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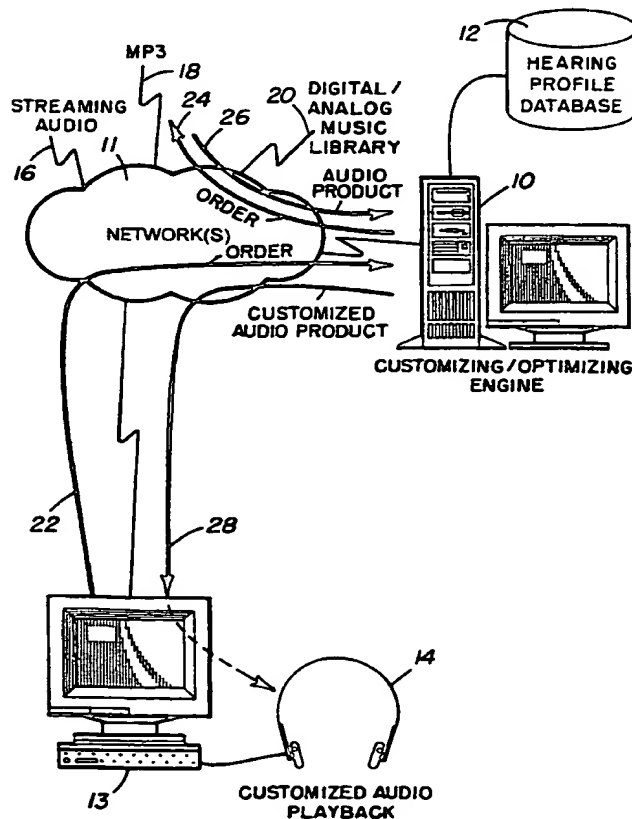
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(54) Title: PRODUCING AND STORING HEARING PROFILES AND CUSTOMIZED AUDIO DATA BASED



(57) Abstract: A method for providing customized audio data products that includes the steps of (1) storing a machine readable hearing profile for a customer, (2) accepting via a data input device or data network for example, machine readable orders from the customer for a particular audio data product, (3) associating the hearing profile for the customer with the particular audio data product, (4) modifying the particular audio data product according to the hearing profile to produce a customized audio data product, (5) delivering the customized audio data product to the customer, for example via a network or by a machine readable storage medium, (6) accepting feedback from the customer concerning the objective or subjective performance of the customized audio data product, and (7) modifying the hearing profile in response to the feedback provided. An audio playback device for playing back customized audio products based on the hearing profiles, and a hearing test device for use in the generation of hearing profiles are provided. The customized audio data product can be delivered using a network, or provided on an article of manufacture that comprises a data storage medium that is configured for connection to and for disconnection from an audio playback device. In one embodiment, an audio playback device and a hearing test device for producing hearing profiles are combined in a single appliance including a headset and earphones.

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PRODUCING AND STORING HEARING PROFILES AND CUSTOMIZED AUDIO DATA BASED

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BACKGROUND OF THE INVENTIONField of the Invention

10 The present invention relates to the distribution, customization and playback of audio data products, like telephone signals, music batch files, and streaming audio data. In particular, the present invention provides for distribution and/or playback of audio data products customized according to a hearing profile of a customer, and for techniques for the production of hearing profiles for customers.

15 Description of Related Art

 The hearing profiles of individuals vary in a number of ways. The ability to hear sounds varies with frequency among individuals across the normal audio frequency range. Also, the dynamic range varies among individuals so that levels of audio stimulus that are perceived as soft sounds and levels of audio stimulus that are perceived as loud sounds differ from person to person. Standard hearing tests are designed to produce an audiogram that characterizes such factors as frequency, sensitivity, and dynamic range in the hearing profiles of individuals. There are also other factors that affect a hearing profile. For example, psycho-acoustic factors concerning the manner in which a person perceives combinations of normal sounds affect the ability to hear in manners that can vary from person to person. Also, environmental factors such as the usual listening environment of a person (library, conference room, concert hall) and the equipment on which the sound is produced (loud speaker, ear phones, telephone hand set), are important. In persons wearing hearing aids or using other assistive hearing devices, the type of aid or device affects the hearing profile. The physiology of an impairment suffered by the individual may also be an important factor in the hearing profile.

30 Audio products that are distributed to customers in digital or analog electronic form are intended for persons having hearing profiles within a normal range. For example, a popular



compression technique for musical compositions being distributed across the Internet, known as MP3, is based on the psycho-acoustic model of a typical listener. Thus, some persons have hearing profiles that may interfere with enjoyment of MP3 compressed music. Other persons may have hearing profiles which make it difficult to understand normal telephone conversations using audio data from the telephone network. Also, individuals may have hearing profiles which make it impossible to enjoy a musical composition in the way which it was intended by the composer or musician, even if it were played back with very high fidelity. Other audio data products, such as streaming audio over the Internet, telephone calls over land line or wireless networks, audio accompanying television programs, radio broadcasts, live radio format broadcasts over the Internet, prerecorded audio books and the like, may be difficult for persons having some hearing profiles to fully enjoy.

The hearing profiles of individuals have been applied in the hearing aid field for customizing and fitting hearing aids for individuals. See, for example, U.S. Patent No. 4,731,850 entitled PROGRAMMABLE DIGITAL HEARING AID SYSTEM, invented by Levitt et al.; and U.S. Patent No. 5,848,171 entitled HEARING AID DEVICE INCORPORATING SIGNAL PROCESSING TECHNIQUES, invented by Stockham, Jr. et al. Thus, techniques for processing sound to offset variations in hearing are well known. However, these techniques are unavailable to persons not using hearing aids. Furthermore, many persons who could benefit from such processing are not in positions to use hearing aids, for a variety of reasons.

Accordingly, it is desirable to provide systems and methods to apply techniques for the processing of audio data according to hearing profiles for the benefit of individuals who are not wearing hearing assistance devices. Also it is desirable to provide tools to simplify the gathering of information needed to develop hearing profiles of individuals, and to apply the gathered information in the distribution and customization of audio data products.

SUMMARY OF THE INVENTION

The present invention provides customized audio data products, and systems and methods for producing the customized audio data products, for a customer, who may be an individual or a group of individuals, processed according to a hearing profile of the customer. Also, the present invention provides tools for gathering information concerning a customer's hearing profile, and for establishing and optimizing such profile for use in the production of the customized audio



data products. According to the present invention, the quality of life as it relates to enjoying music, talking on the telephone, and participating in other listening activities can be improved for a wide range of individuals having hearing profiles that are not typical, whether or not the individual has been fitted with a hearing aid or other assistive hearing device.

5 In addition, the present invention provides an audio playback device for playing back customized audio products based on the hearing profiles, and a hearing test device for use in the generation of hearing profiles.

The customized audio data product can be delivered using a network, or provided on an article of manufacture that comprises a data storage medium that is configured for connection to
10 and for disconnection from an audio playback device. In some embodiments, the customized audio data product is stored in the data storage medium. The data storage medium comprises in various aspects a CD-ROM, a DVD disk, a floppy disk, a solid state memory card, and other portable memory devices. In another embodiment, the data storage medium comprises a fixed memory element of an audio playback device, such as a personal computer with appropriate
15 decoding and sound production resources.

In one preferred aspect of the invention, a hearing test device and an audio playback device comprise a single appliance such as a mobile phone, radio, wireless communication device, personal digital assistant with or without a wireless link, or music playback device, and may be coupled with or mounted on a headset. In one example, the appliance is a small portable
20 unit comprising an audio processor, an audio transducer such as ear phones, an optional removable storage media port and a communication port packaged with a battery. The audio processor includes logic implemented using software, hardware or a combination of hardware and software supporting a hearing test, and supporting the decoding of customized audio data products. The removable storage media port is adapted to receive a solid state memory card or
25 other removable memory device on which the customized audio data is stored. In various embodiments, both circuit components and earphones of the appliance are mounted in an ergonomic manner on a headset. In alternatives, circuit components of the appliance are packaged in a portable format and coupled to a headset using cables or wireless connections.

The communication port on the appliance in this aspect of the invention is adapted for
30 connection to a data processor such as a personal computer that provides a user interface for support of the hearing test. The data processor can be coupled to the network across which

access to sophisticated testing resources may be provided, or can comprise sufficient resources for conducting the test without access to remote resources.

Logic on the appliance comprises resources for the generation of the sounds used in the test in response to signals from the data processor. The data processor provides signals produced in response to user input provided during a testing, and signals produced in response to the testing algorithms being executed. User input generated during a testing is used for the production of a hearing profile for the customer. Customized audio products are produced using the hearing profile, and provided on a portable storage medium for connection to the removable storage media port on the appliance. The customized audio products may be played using the same appliance as used in the generation of the hearing profile. In addition, the hearing profile may be stored on the appliance itself, and used for the production of customized audio products in the appliance based on data products from a wide variety of sources.

Also, the customized audio products may be played on other devices, and stored in other formats as suits the particular needs the customer. Likewise the hearing profiles may be used, optimized and distributed in a variety of ways.

In one preferred aspect of the invention, a method executed by a system for providing customized audio data products includes the steps of (1) storing a machine readable hearing profile of a customer, (2) accepting via an input device or data network for example, machine readable orders from the customer for a particular audio data product, (3) associating the hearing profile of the customer with the particular audio data product, (4) modifying the particular audio data product according to the hearing profile to produce a customized audio data product, (5) delivering the customized audio data product to the customer, for example via a network or by a machine readable storage medium, (6) accepting feedback from the customer concerning the objective or subjective performance of the customized audio data product, and (7) modifying the hearing profile in response to the feedback.

In one embodiment of the present invention, the hearing profile and the audio data product are delivered to the customer via separate channels. In one example, the hearing profile is sent via one communication channel to a machine, such as a set top box, at the location in which the audio data product is played, and the audio data product is sent via another communication channel. According to this example, the hearing profile may be provided over the Internet, while the audio data product is provided via a television cable network. In another



embodiment, the hearing profile is stored in a portable data storage device, such as a card having a magnetic strip memory, or a card having a non-volatile integrated circuit memory. The hearing profile of the customer in this embodiment is stored on a machine using a portable data storage device. The audio data product is customized by the machine using the hearing profile prior to playback.

The system in various embodiments provides input tools, such as a graphical user interface usable, for example, at a kiosk or accessible via a network, for accepting input data concerning a hearing profile of a customer, either supported by a specialized hearing test device as described above or by other resources for use in the test. The input tools are used for creating a machine readable hearing profile, which is stored in a registry of hearing profiles for use in the production of customized audio data products. Alternatively, the hearing profile is stored on a portable data storage medium for use by the customer, as described above.

Also, in various embodiments of the invention, the system provides tools for accepting input data characterizing the feedback from the customer. Processing resources are provided for modifying the machine readable hearing profile in response to the feedback data. The modifying of the machine readable hearing profile in one aspect of the invention comprises applying an optimization modeling process to the hearing profile, by which the profiles are improved over time using feedback arising from a variety of customized audio data products and from a variety of listening conditions.

According to other aspects of the invention, the system includes resources for determining a type of delivery for the customized audio data product, such as by prompting a customer to select a delivery mode. The step of modifying the particular audio data product is responsive to the type of delivery requested by the customer. Thus, for example, if a customer requests a music batch file to be delivered using the MP3 compression technique, the processing algorithm applied, or the parameters applied in a single algorithm, may be different than that applied if the customer requests a telephone conversation delivered via a telephone network customized according to the customer's hearing profile.

The present invention also provides a system that includes a source of an encoded audio data product, and processing resources that are configured to receive a request for the encoded audio data product, and to associate the encoded audio data product with a customer hearing profile. The customer hearing profile is used for production of a customized audio data product.



The customer hearing profile comprises in various embodiments, the coefficients of the transfer function used to transform an audio data product according to a hearing characteristic of a customer, and an identifier of a transfer function used to transform the encoded audio data product, an identifier of a transfer function and coefficients for the identified transfer function, values indicating listening conditions in which the customized audio data product is to be played, specification of psycho-acoustic characteristics of a customer, an audiogram characterizing physical hearing characteristics of a customer, and executable software defining a transfer function for producing the customized audio data product. Thus it can be seen that the hearing profile used for production of the customized audio data product according to the present invention assumes a structure adapted to the distribution of processing and communication resources in the particular system being utilized.

The data processing resources are adapted according to the network resources available. Thus, the processing power for transforming the selected audio data product into the customized audio data product can be positioned at a central location accessible via a network, it can be distributed at a variety of locations in the network, it can be positioned in the playback device at a customer's home or office, and it can be implemented using combinations of processors located in several sites.

The architecture of the system can assume a variety configurations. In one aspect, the processing resources in the system include a network interface and logic to accept via the network interface data concerning the customer for use in producing the customer's hearing profile. In other embodiments, the system includes a source of a plurality of customer hearing profiles, such as a customer registry. In response to a request for particular audio data product, the hearing profile is retrieved from the registry and used for production of the customized audio data product.

A variety of user interface tools, such as Web pages, other tools accessible via a network, graphical user interfaces executed on a customer terminal, graphical user interfaces executed at a terminal in a kiosk, personal digital assistant (PDA) devices with network interfaces, and telephones, are included in various embodiments of the invention for accepting data concerning hearing profiles, selections of audio data products, selections of delivery modes, and other input data utilized in the system.



The resources used for associating a customer hearing profile with an audio data product are centrally located at a site accessible via a network by a large customer base. However, in various embodiments, these resources can be distributed among a variety of sites accessible via a network. In a similar manner, the database for storing the hearing profiles of customers is coupled with the site used for associating the hearing profile with encoded audio data product. Alternatively, the database is distributed among a variety of locations for the purposes, for example, of load balancing, security and redundancy.

The customized audio data product is likewise implemented according to the particular configuration of the network processing and communication resources. Thus, the customized audio data product in various embodiments consists of the hearing profile, or portions of the hearing profile, concatenated with the selected audio data product for processing, or further processing, after delivery. In other embodiments, the customized audio data product includes the encoded audio data product transformed using the hearing profile, and ready for play back, prior to delivery. The transformed audio data is coupled to identifiers such as addresses or customer codes in various embodiments, which may be used in decoding the transformed data.

The encoded audio data product, which is customized and delivered according to the present invention comprises in various embodiments analog or digital instances of pre-recorded audio tracks, pre-recorded audio music tracks, live audio music streams, pre-recorded audio voice tracks, live audio voice tracks, live audio telephone data, audio tracks associated with television programs or movies, or other kinds of batch or streaming mode audio data.

The present invention also supports a variety of modes of delivery for the customized audio data product. The customized audio data product is delivered in various embodiments by providing resources to store the customized audio data product on machine readable storage media, such as CD ROM, DVD, or other storage media formats suitable for shipping to the customer. In one preferred embodiment, the customized audio data product is transmitted via a network to the customer using a format such as MP3, formats for voice over the Internet VoIP, or standard telephone formats. The network in various embodiments includes the Internet, a private network, a telephone network, a satellite communications network, or other wired or wireless communication technologies. The transmitted customized audio data product is adapted for a particular playback device in one embodiment. Thus, the product is adapted for transmission to a



personal computer, to a hand-held PDA having a wireless communication link, or directly to a playback device with a wired or wireless network interface.

Thus, the present invention provides a comprehensive system and method for providing audio data products customized according to individual hearing profiles of customers. The system and method operate without requiring assistance of specialized listening devices or hearing aids and allow for optimization of the hearing profiles and customizing processes according to characteristics of the customer, to the particular audio data product being customized, and the listening environment in which the product is to be enjoyed. Utilizing the techniques of present invention, greater numbers of people may take advantage of the processing techniques developed in the hearing aid arts to account for variations in hearing profiles of individuals. Further, the need for hearing aids or other assistive listening devices will be reduced, and many people will be able to avoid the need for such devices completely.

Other aspects and advantages of the present invention can be seen on review of the drawings, the detailed description, and the claims which follow.

BRIEF DESCRIPTION OF THE FIGURES

Fig. 1 is a diagram of one example system for delivering customized audio data products according to the present invention.

Fig. 2 illustrates a method for delivering customized audio data products according to the present invention.

Fig. 3 is a heuristic diagram illustrating a variety of system configurations and implementations of the present invention.

Fig. 4 is a diagram of one example of a customized audio data product according to the present invention.

Fig. 5 is a diagram of another example of a customized audio data product according to the present invention.

Fig. 6 is a diagram of one example of a hearing profile for use in producing customized audio data products.

Fig. 7 is a diagram of another example of a hearing profile for use in producing customized audio data products.



Fig. 8 is a diagram of yet another example of a hearing profile for use in producing customized audio data products.

Fig. 9 is a simplified diagram of a user interface for selecting a particular audio product in conjunction with the system of the present invention.

5 Fig. 10 is a simplified diagram of a user interface for setting up a hearing profile for a customer in conjunction with the system of the present invention.

Fig. 11 is a simplified diagram of the user interface for obtaining feedback from a customer concerning a hearing profile in conjunction with the present invention.

10 Fig. 12 illustrates environments in which input data is received from customers in conjunction with the production and optimization of hearing profiles according to the present invention.

Fig. 13 illustrates optimization loops, and the interaction among optimization loops for producing hearing profiles according to the present invention.

15 Fig. 14 illustrates processing resources for dynamic optimization of hearing profiles according to the present invention utilizing reference model adaptive control techniques.

Fig. 15 illustrates a graphical user input tool for the purposes of gathering information concerning a hearing profile of a customer.

Fig. 16 illustrates another graphical user input tool for gathering information concerning hearing profiles of customers.

20 Fig. 17 illustrates a second level graphical user input tool used in the conjunction with the input tool of Fig.16.

Fig. 18 illustrates another second level graphical user input tool used in the conjunction with the input tool of Fig.16.

25 Fig. 19 illustrates a configuration of an alternative system according to the present invention in which the hearing profile is applied in a set top box, and delivered via a communication channel different than that used for the audio data product.

Fig. 20 illustrates a configuration of an alternative system according to the present invention in which the hearing profile is provided using a portable storage device for use by a customer to produce customized audio data.

30 Fig. 21 illustrates a configuration of an alternative system according to the present invention in which the customized audio data is provided on a portable storage device.



Fig. 22 illustrates a combination hearing test and playback device for customized audio data according to the present invention.

Fig. 23 illustrates an alternative implementation of a combination hearing test and playback device for customized audio data according to the present invention.

Fig. 24 is a block diagram of a hearing test and playback appliance for use with the device of Figs. 22 and 23.

DETAILED DESCRIPTION

A detailed description of the various embodiments of the present invention is provided with reference to Figs. 1 through 24.

Fig. 1 provides an illustration of one example system for delivering customized audio data products. Other examples will be discussed below. The system includes a server 10 which is coupled to a network or networks 11 for communication with other network connected devices. The server 10 is also coupled to a database 12 storing hearing profiles of customers. In this example, a customer has a personal computer 13 which is coupled to the network or networks 11. The personal computer 13 includes data processing resources, such as memory, a graphical user interface program, and a digital signal processing based sound board coupled with ear phones 14 for playing back an audio product stored in the PC or being received by via the network through the PC. The network or networks 11 interconnect services to supply audio data products. In this example, suppliers of streaming audio are represented by the line 16, suppliers of MP3 batch files are represented by the line 18, and suppliers of digital and analog music library files are represented by the line 20.

In this example, the server 10 includes a variety of data processing resources, including a network interface or interfaces, a host processor for managing an Internet based service, memory resources, and a processor, such as a digital signal processor, used in the customizing of audio data products, and used for optimizing hearing profiles stored in the database 12. In this example, the network interface or interfaces of the server 10 act as a source of audio data products. The user issues an order ORDER via the network as represented by line 22, for a particular audio data product. Resources in the server 10 translate the order into a form



ORDER', as represented by line 24, for retrieving the audio data product from the network. The particular audio data product requested by the customer is returned via the network as represented by line 26 to the server 10. Data processing resources in the server 10 associate a hearing profile from the hearing profile database 12 with the particular audio data product. The customized audio data product is then returned as represented by line 28 via the network to the customer PC 13. The PC 13 processes the customized audio data product and supplies it for customized audio playback at the ear phones 14.

The system of Fig. 1 also provides data processing resources for gathering information needed for developing and storing hearing profiles in the database 12. In addition, the system includes resources for obtaining feedback from customers used in the optimizing of hearing profiles.

Fig. 2 illustrates a basic method of operation of a system according to the present invention. Although Fig. 2 is drawn in the form of a flow chart, the particular sequence of steps can be modified as suits particular implementation or context of execution.

A first step in the method is to characterize the hearing of a customer (block 50). The hearing of a customer can be characterized in the system of the present invention indirectly, such as by entering an audiogram, entering the make of the hearing aid and associated prescription, if any is used by the customer, or entering responses to questionnaires. This indirect input data is processed by the system to produce a hearing profile which can be used in a production of customized audio data products. Alternatively, the hearing of a customer may be characterized directly. For example, a customer may sample a closed set of hearing profile choices and select a preferred one. Alternatively, a network based test can be executed by which information needed for administering the test is delivered to the customer via the Internet or other network, and the customer's responses to stimulus in the test are returned via the network to the processing resources in the system. In another example, a kiosk is set up in a public location for use by customers to establish a hearing profile using the processing resources of the kiosk designed for administering the hearing tests. In yet another embodiment, a test is administered over the telephone, particularly when the audio data product to be delivered is telephone calls. These direct measurements of the hearing profile of customer are processed by the system into hearing profiles used for customizing audio data.

Another process in the method of the present invention is to determine the listening conditions in which the customer will be using the customized audio data product (block 51). The listening conditions may include free field environments in which the transducers consist of loud speakers in a living room being driven by a television, radio, or a home stereo, speakers in an automobile driven by the automobile sound system, or concert conditions of some sort. Other listening conditions may be monaural, such as a telephone or an existing prosthetic device. In another example, listening conditions consist of binaural settings, in which sounds are to be delivered via a headset or a binaural prosthetic device. The listening conditions can be characterized in the hearing profile to be applied for producing the customized audio data product.

The next process illustrated in Fig. 2 in the method of the present invention involves determining the mode of delivery of the audio data product which the customer has requested (block 52). After it has been customized, the audio data product can be delivered on a storage medium, or via a network. Also, the format of delivery, such as an MP3 batch file to be played after it has been delivered and stored on the customer's machine, or a streaming audio product which can be listened to while it is being downloaded from the Internet from a live source or from a stored library of audio products, may be subject to different customization algorithms.

The system also includes resources for determining the audio product requested by the customer (block 53). These resources may be implemented using well-known Internet server techniques for commercial transactions and for presenting catalogs of goods or services. Examples of audio products which may be requested include pre-recorded music, live music performances, radio broadcasts, radio format streaming audio products, telephone calls, television shows, audio books and any other audio data source.

Based upon one or more of the processes in blocks 50-53, the system determines the processing needed to customize the audio data product (block 54). The information gathered in the processes of blocks 50-53 is applied using the principles developed for customizing and fitting hearing aids, and improved using adaptive optimization processes as discussed below.

The processing is applied, and the customized audio data is provided to the customer according to the mode of delivery requested (block 55). The customized audio data may take on a variety of formats as discussed in more detail below.



Another process provided by the system is to obtain customer feedback concerning the objective and subjective performance of the customized audio data (block 56). The feedback is retrieved using Internet based techniques for gathering data in one embodiment. Alternatively, customers can be called on the telephone or prompted to fill out questionnaires to rate the performance of the products.

Utilizing the feedback obtained, the hearing profiles are adjusted (block 57). Adjustments may be made either on the fly, or offline as is determined by the processing resources available, and the type of product being delivered. For example, for streaming audio products it may be desirable to optimize the customization of the product on the fly so that the customer can experience the improvements resulting from feedback being returned to the system within a short period of time.

The final process illustrated in the method of Fig. 2 is to update the database used for storing hearing profiles based upon the adjustments made in response to customer feedback (block 58). In this manner, a database is developed of hearing profiles, including the adjustments made to hearing profiles based on specific kinds of feedback for specific kinds of audio data products. Using information in the database, the system is able to improve techniques for establishing and adjusting hearing profiles over time according to adaptive optimization techniques. In addition, the database may be used to as a resource for delivering other products to the customer.

Fig. 3 is a diagram used for illustrating a variety of configurations of the system of the present invention. It will be apparent to persons of skill in the art that a large number of variations in architecture for a network based data processing system can be applied, depending on such issues as load balancing, security, reliability, and speed.

Fig. 3 illustrates a system that includes a network server 100 which is coupled to a network or networks 101. A plurality of customer end stations, including customer end station 102, customer end station 103, customer end station 104, and customer end station 105 are coupled to the network 101. Also, the network interconnects suppliers of audio data products, such as audio data product server 106. The network server 100 also includes a separate link 107 to another supplier of audio data products 108. Also, connected to the server 100 via a link 109 is a registry of customer hearing profiles 110, such as a database which stores hearing profiles accessible using customer identifiers. In this example, a transform engine 111 is coupled to the



network server 100 via link 112, and also to the network 101. The transform engine 111 includes the resources for applying hearing profiles to an audio data product, in order to produce the customized audio data products for delivery to the customer. The configuration of Fig. 3 also includes other transform engines distributed in the system. Thus, the server 106 for delivering
5 audio data products includes a transform engine 113. Also, the customer end station 105 consists of a personal computer including a transform engine 114 based on, for example, a digital signal processing card.

The customer end stations 102-105 illustrate a variety of playback modes which may be served by the system of the present invention. Thus, the customer end station 102 consists of an
10 MP3 player, which transduces batch mode MP3 music files for supply to ear phones 115. The customer end station 103 consists of a personal computer which is coupled to a stereo receiver 116 which drives loud speakers 117. Customer end station 104 consists of a telephone which supplies the customized audio data to a telephone handset 118. Customer end station 105 consists of personal computers with an on-board transform engine which supplies the audio data
15 transformed to match the hearing profile of the customer to ear phones 119.

The network 101 is illustrated in Fig. 3 as a single entity. However, the network may comprise a plurality of networks, including the telephone network, the World Wide Web, private networks, land based wireless networks, satellite communication networks, and other forms of data communication. The plurality of networks by which audio data products may be
20 communicated can be used alone, or in combination as suits the particular communication channel being set up to deliver the product.

In one preferred mode, the particular audio data product selected by the customer has a particular format, such as an MP3 format. The customized audio data product is also delivered in the particular format of the original audio data product. In this manner, the customer is able to
25 playback the customized audio data product using the type of equipment for which the original product was developed. In alternative embodiments, the customized audio data product is transformed from the format of the original audio data product into the format of the listing device in which customer intends to play back the customized audio data product.

The server 100 in one preferred embodiment includes resources for keeping information
30 used for billing the customer for ordered customized audio data products.



Figs. 4 and 5 illustrate alternative formats for the customized audio data product according to the present invention. In Fig. 4, the customized audio data product consists of a header 200 that includes, for example, a destination address, a field 201 holding the hearing profile, or portions of the hearing profile, and a field 202 holding the audio data product which has been retrieved and modified by the addition of the header 200 and hearing profile 201. The format of customized audio data product shown in Fig. 4 is utilized when the transform engine is located at the customer site or remote from the server at which the hearing profile is associated with the audio data product to be delivered.

Fig. 5 illustrates an alternative format for a customized audio data product which includes a header 210, including a destination address or other parameter like a digital signature or user identification number identifying the customer or associating the customized data product with the customer, and a field 211 holding a transformed version of the audio data product. The format of customized audio data product shown in Fig. 5 is utilized when the transform engine is coupled with the network server which associates the hearing profile with the particular audio data product to be delivered. The parameter, such as the address, user identification number or digital signature mentioned above, is used in decoding the transformation of the audio data product in one embodiment.

According to the present invention, an article of manufacture comprises the customized audio data product having a format such as those shown in Figs. 4 and 5, stored on a storage device, such as machine readable, portable non-volatile memory device.

Figs. 6, 7 and 8 illustrate alternative formats for the hearing profiles to be stored in the registry 110. The hearing profile shown in Fig. 6 includes a customer ID 250, coefficients of transform equations 251, and an identifier of the playback device type and listening environment 252 in which the audio data product is to be played. In Fig. 7, the hearing profile includes a customer identifier 260, the audiogram for customer 261, listening condition data 262, and psycho-acoustic parameters 263 which relate to the listening characteristics of the customer. The hearing profile shown in Fig. 8 includes a customer identifier 270, and software 271 along with code data structures 272 that in combination provide executable transform code for producing the customized audio data product from the selected audio data product. The three examples of hearing profile formats shown in Figs. 6-8 are representative of a large number of hearing profile

formats that could be utilized depending on the type of transform processes being executed, the type of audio products being delivered, and other factors related to the architecture of the system.

According to the present invention, an article of manufacture comprises the hearing profile having a format such as those shown in Figs. 6, 7 and 8, stored on a storage device, such as machine readable, portable non-volatile memory device.

As mentioned before, the system of the present invention provides user input tools for selecting audio products, for setting up hearing profiles, and for providing feedback about the performance of the customer's audio data products. Figs. 9 through 11 show simplified graphic user interface pages used for prompting a user to input data for these purposes. Thus, Fig. 9 shows a page 300 prompting the user to select an audio product. The page 300 includes a first graphical tool 301 for selecting an MP3 music file; a second graphical tool 302 used for selecting streaming audio such as a radio format data, and a third tool 303 used for selecting live audio products, such as a web broadcast performance, or telephone call. Fig. 10 shows a simplified user interface page 310 for setting up a hearing profile. In this example, the page 310 includes a tool 311 for entering audiological data, such an audiogram. The tool 312 is provided for allowing a user to enter playback device types. The tool 313 is included on the page 310, prompting the user to enter environmental parameters. Fig. 11 shows a simplified user interface page 320 prompting the user to provide feedback concerning the hearing profile. Thus in this example, the tool 321 is provided prompting the user to enter subjective performance data, such as whether the customized audio data products sounded good or bad, or whether the pitch of the product was too high or too low. Also, tool 322 is provided to allow the user update the playback device types being used. Finally, in the example of Fig. 11, the tool 323 is provided by which the user is prompted to update parameters about the environment. The pages shown in Figs. 9-11 are obviously simplified versions showing a range of possibilities for input tools provided by the system of the present invention.

Fig. 12 illustrates a variety of scenarios by which a central server 400 interacts with customers in the development and optimization of hearing profiles, and for the selection and delivery of customized audio data products. Thus, the system in Fig. 12 consists of the server 400 which is coupled to the database 401 storing hearing profiles. The server 400 is coupled to the Internet 402, and via Internet 402 to a kiosk 403, and to a plurality of other locations, including a personal computer 403 at the home of the customer, and via wireless link 405 to a



personal digital assistant 406, by which the customer provides feedback away from home. The kiosk 403 includes a computer 410 having a graphical user interface such as a touch screen 411 for administering a hearing test to gather data for development of hearing profiles. In the preferred embodiment, sounds used in the test are provided using an acoustic dome 411, such as the stereo sound dome unit known as a Virtual Audio Imager provided by Brown Innovations, Inc. of Chicago, IL. Utilizing the acoustic dome 411, carefully controlled audio vectors are generated and directed to the customer for use in direct measurement of the customer's hearing profile. A sequence of graphic user interface screens are presented on the touch screen 412, in combination with the audio stimulus provided by the acoustic dome 411. The user's hearing profile is developed based on interaction via the touch screen 412.

The personal computer 404 at the customer's home is utilized for follow-up interaction with the customer, or for gathering indirect data concerning the hearing profile of customer. Thus, via the Internet 402, the server 400 can deliver questionnaires and simple audio tests to the home PC 404. Also, a user can access a web page, or use electronic mail, to provide feedback concerning the performance of the customized audio data product that had been played by the user. Finally as shown in Fig. 12, the user may access the server 400 using a wireless personal digital assistant 406 to provide feedback concerning the performance of the customized audio data product.

Fig. 13 illustrates optimization loops used for the production of a customer's hearing profile according to the present invention. The first optimization loop A is based on administration of an interactive test. For each customer, the vector "s" representing a sound environment, a vector "f" representing a fitting parameter, and a vector "e" representing the customer's evaluation at this stage of the test is developed. The sequence of stimuli is applied to produce the vectors. The vectors are applied to a second loop C. In the second loop C, a fitting algorithm is executed based upon the aggregate of data from many patients. In this loop, data mining techniques can be used to make a best initial guess of the fitting to be applied to customer. The fitting being developed for the customer is applied to a feedback loop B. In the feedback loop B, the fitting "f" developed during the test for the profile represented by transform g' is applied to a real world environment g' . The evaluation "e" provided by the customer in response to the real world experience is used in feedback for the purposes of optimization of the fitting.



Fig. 14 illustrates processing resources used in the adaptive optimization of a hearing profile according to the present mention. The customer's profile "p" is applied to a fitting processor 500. Other inputs to the fitting processor 500 include prior evaluation data provided on line 501, prior sound environment data delivered online 502, and customer input. A particular fitting vector "f" is provide on line 503. This fitting vector is processed according to a transfer function 504. Customer evaluation of the playback is provided on line 501. The fitting vector on line 503 and the evaluation on line 501 are fed to a performance correlation unit 505. The performance correlation unit 505 generates a result that is applied to data mining resources 506 for the purposes of determining a reaction to the correlation result. Data mining produces parameters used in testing optimization unit 507. A testing optimization unit 507 updates the environmental parameters for the customer. The data mining resources 506 are seeded with the information gathered from prior evaluations for given customers. Thus, model reference adaptive learning using data mining techniques can be utilized to optimize the fitting for a particular customer. For additional information concerning model reference adaptive optimization techniques, reference can be made to LANDAU, *ADAPTIVE CONTROL, THE MODEL REFERENCE APPROACH*, Merkel Dekker, Inc., New York, 1979.

Figs. 15-18 illustrate graphical user interface tools for use in a kiosk environment such as the kiosk 403 shown in Fig. 12, for development of a hearing profile using direct measurements. The user interface of Fig. 15 provides a simple interface for gathering information about the profile the user. The tool includes a first indicator 600 for signaling to a user whether the left or right ear is being stimulated. Next, a label using either text or graphics is displayed for indicating to the user that a test for loudness is being made. Next, a label 602 for bass and treble tests is provided. A label 603 for testing clarity is provided. A label 604 is provided identifying tests for noise and distortion. The user is given the option of making three selections for each test represented by a left facing arrow 605, a center button 606, and a right facing arrow 607. Thus, for example during a loudness test for the left ear, an indicator in region 600 identifies stimulus to the left ear. A sound is played using the acoustic dome 411 shown in Fig. 12. The user selects the left arrow if the tone is too loud, the right arrow if the tone is too soft, and the center button 606 if the tone sounds right. Similar stimulus-response tests are administered for the other factors to be determined. The upper left-hand section of the screen includes a button 608 to signal to repeat of the test, and a button 609 to signal that the user is ready to proceed to a

next test. Using this stimulus-response technique, with limited feedback options, a basic hearing profile can be developed without professional assistance.

Figs. 16-18 illustrate another technique for gathering feedback from a customer during the development of a hearing profile. A first screen as shown in Fig. 16 is displayed with a row of condition indicators 700-702 across of the top of the screen. The indicators show whether the test being executed is adapted to determine soft sounds, normal sounds, or loud sounds. An array of 16 buttons arranged in a 4 by 4 matrix in this example is displayed to the user. A set of sound stimulus is played, and the user is instructed to select a corresponding button in the 16 button array. After a first selection, preferably within the interior four buttons in the region 703 of the array, a second screen, such as the screen shown in Fig. 17 is displayed to the customer, linked to the choice made in the first screen. The second screen of Fig. 17 includes a second array of 16 buttons presented to the user. The user again selects a preferred setting for a loudness over balance of the stimulus to further refine the profile data. Fig. 18 illustrates another second level screen for the purposes of selecting the preferred level of clarity over noise and distortion for the signal. Utilizing these graphical interface tools in combination with audio stimulus, relatively sophisticated information concerning users' hearing profiles can be gathered automatically by an Internet based, or kiosk based, testing system.

Fig. 19 illustrates another system configuration for the delivery of customized audio data products according to the present invention. The system includes a customized audio server 900 which is coupled to a network or networks 901 for communication with other network connected devices. The servers are also coupled to a hearing profile database 902, such as described above. In this example, a customer has a display system 903 which may be a computer monitor, a television, or another device that is coupled to the network or networks 901. The display system 903 is coupled to an audio system for providing playback of the customized audio, in this example using headphones 904. Also coupled to the display system is a set top box 905 by which the display system is coupled to the network or networks 901. The set top box 905 combines the hearing profile data and the program including audio data to produce the customized audio data product at the customer site.

In one example, the set top box is coupled to a cable television network 906 across which movies and television programming that include audio data products are supplied to the display system 903. Thus, one source of audio data products coupled to the network or networks 901 is

cable television network 906. Other sources of audio data products coupled to the network or networks 901 include streaming audio data 907, MP3 encoded audio data 908, and a digital/analog music library 909.

The customized audio server 900 acts as a gateway for managing the delivery of customized audio data products. In this example, the customized audio server 900 is also coupled to the telephone network, as indicated by the telephone 910. One example transaction using the system of Fig. 19 includes placement of an order for customized audio data products using the telephone 910 using touch tone commands or voice recognition mechanisms. When the order is placed to the customized audio server 900, a request is issued to the source of the requested audio data product, in this example to the cable television network, for delivery of a chosen audio data product. Also, the customized audio server 900 transmits a hearing profile to the set top box 905 across a communication channel between the customized audio server 900 and the set top box 905. The cable television network 906 transmits the requested programming including the audio data product to the set top box 905 using a separate communication channel. Thus, for example, the hearing profile is transmitted from the customized audio server 900 to the set top box 905 using the Internet, while the programming is supplied from the cable television network 906 using the television cable protocols and media. Also, separate Internet channels may be used for the independent channels from the customized audio server 900 and from the source of the audio data.

In other transactions using the system of Fig. 19, the order may be placed via the communication link between the set-top box 905 and customized audio server 900, or via other communication links with the customized audio server 900. Also, feedback concerning the performance of the customized audio data product can be provided using the set top box 905 or via other communication channels to the customized audio server 900. In other configurations, the database 902 is coupled to the network or networks 901 at a site apart from the customized audio server 900.

Fig. 20 illustrates another system configuration for producing customized audio data products according to the present invention in which the hearing profile is carried on a portable storage device 950, such as a plastic card having a magnetic strip or carrying an integrated circuit memory. In this example, a hearing profile database 951 is coupled to the network or networks 952. A plurality of sources of audio data products are also coupled to the network or networks

952, including, for example, streaming audio data 953, MP3 encoded audio data 954, cable television network 955, and a digital/analog music library 956. In the system shown in Fig. 20, a kiosk workstation 960 is coupled to the network or networks 952. Using the workstation 960 and the tools described above for the creation of a hearing profile, an individual generates a hearing profile data set. A card writer 961, or other resource for storing data on a portable storage device 950 is coupled to the kiosk workstation 960. The hearing profile data is stored on the portable storage device 950 and the individual carries it to a location at which a playback device 963 is used to play the customized audio. The user has a personal computer 964, or other network connected appliance such as an internet enabled cell phone or palm sized computer, which is coupled to the network or networks 952. Coupled with personal computer 964 is a card reader 965 by which the data in the portable storage device 950 is downloaded to the personal computer 964.

A transaction using the system of Fig. 20 includes a user issuing an order for a particular customized audio data product directly to the source of the product. Thus, in this example, the order for a customized audio data product is placed directly to the digital/analog music library 956. The selected audio data product is delivered to the personal computer 964. The personal computer 964 uses the hearing profile from the portable storage device 950 to produce the customized audio data product, and delivers it to the playback device 963. In one embodiment, the personal computer 964 is also configured to provide feedback information concerning the performance of the customized audio data product. The feedback information is delivered via the network or networks 952 to the hearing profile database server 951.

Portable storage devices carrying hearing profile data may be used in a variety of settings. For example, a card reader may be coupled to a set top box for a cable or satellite television network to allow for the delivery of customized audio data with standard programming. Also, a card reader and headphone set may be installed in a movie theater to allow for the delivery of customized audio data to moviegoers. Card readers may be coupled to telephones to allow for the correction of audio telephone conversations. Examples of portable storage devices include plastic cards with magnetic strips, PC Card format or PCMCIA format add-on cards for computers, flash memory cards, cards like the "Memory Stick" provided by Sony Corporation, a floppy disk, or other machine readable storage devices adapted to be carried from machine to machine.

Also, in various embodiments of the present invention, customer identification data, such as fingerprints or other biometric data, may be recorded and stored with the hearing profile and/or the customized audio data of a customer for purposes of authentication of feedback data, automatic accounting for use of the hearing profile data, or access playback authorization and other purposes.

Fig. 21 illustrates yet another configuration for distribution of customized audio data products according to the present invention. In Fig. 21, the customized audio data product is provided on a portable storage device 1000. The article of manufacture consisting of the portable storage device having a customized audio data product stored therein is produced in a server 1001 coupled to a network or networks 1002. A plurality of sources of audio data products, for example as mentioned before including a source of streaming audio 1003, a source of MP3 audio 1004, a cable television network 1005, and a digital/analog music library 1006, are coupled to the network or networks 1002.

In one example scenario among many possible scenarios, a customer logs on at end station 1007 coupled to the network or networks 1002. A customer places an order by a message ORDER 1008 to server 1001. The server 1001 produces the article by ordering the requested audio data product from a particular source, such as by a message ORDER' 1009 sent to the digital/analog music library 1006. The audio data product PRODUCT 1019 is returned to the server 1001. The server combines a hearing profile for the customer from the hearing profile database 1018 with the PRODUCT 1019 to produce a customized audio data product as described above. The hearing profile is provided by the user in other embodiments via the network or using a portable storage device. The server includes a card writer 1010, or other resources for storing data on a portable storage device. The server uses the card writer 1010 to write the customized data product onto the portable storage device 1000.

The portable storage device 1000 is delivered to the customer, by mail or by hand delivery, or otherwise. A customer uses a playback device 1011 having a card reader 1012, or other port for a removable storage media. For example, the playback device 1011 may be a hand-held audio device like a "Walkman" style device with an interface for "Memory Stick" portable storage technology provided by Sony Corp. or other similar portable playback devices. Other portable storage media include magnetic tape, CDROM format disks, DVD format disks, magnetic disks, and a variety of media adapted for particular environments.

Fig. 22 is a schematic diagram of a hearing test and playback device according to the present invention, used for the production of hearing profiles, and for playing back customized audio data products. The device includes a headset 1100 having ear phones 1101 and 1102. The headset is coupled by a communication medium such as cable 1103, to a handheld appliance 1104. The appliance includes a port for a removable storage device 1105, and a port for a communication medium 1106. The communication medium 1106 is coupled to a computer 1107 which is coupled to a data network medium 1108. The computer 1107 includes a user interface supporting the hearing test, such as described above with respect to Figs. 9-11 and 15-18. The computer is in turn coupled to the data network medium 1108, for access to hearing test resources located remotely in the network. The computer 1107 acts as an intermediate station supporting the hearing test. In an alternative embodiment, the computer 1107 includes the resources locally sufficient to execute the test without relying on access to other resources via the network medium 1108. The appliance 1104 includes resources for playing sounds as directed by signals from the computer produced in response to the user input, and in response to the algorithms of the test. The appliance is designed so that the sounds produced on the ear phones during the test are calibrated to support accurate test results. In this embodiment, the appliance 1104 is a small device adapted to be handheld, or to be conveniently carried in a pocket or handbag, for example.

Fig. 23 illustrates an alternative embodiment of the portable test/playback appliance. In Fig. 23, the circuit components of the device in appliance 1104 are mounted on the headset 1120 along with the ear phones. Of course, Fig. 23 is a simplified diagram. In a preferred embodiment, the circuit components in the appliance 1104 are mounted using an ergonomic design within the structure the headset. In this embodiment, the appliance 1104 includes the port for portable storage device 1105, and the port 1106 for a communication media used for connection to a computer, or via a network like the internet, the wire line telephone network, the wireless pager network or mobile phone network to a remote system. The port 1106 may be a wireless connection or a cable connection as suits particular implementation.

Fig. 24 is a simplified block diagram of the circuit components of the test/playback appliance 1104. The appliance may be a mobile phone, a music play back device, a radio, a wireless appliance, a combination product or other audio product. The appliance 1104 includes an audio processor 1125. The audio processor is coupled to a removable storage media port

1126 and a communication port 1127. The battery 1128 powers the components of the appliance 1104, as well as the ear phones on the accompanying headset. The audio processor 1125 includes logic, such as software stored in a non-volatile memory 1129 for supporting the hearing test, and for supporting the decoding of customized audio data products stored in a solid state
5 memory card 1130 or other portable storage device coupled to the port 1126. If this example, the nonvolatile memory 1129 includes a set of test sounds which are adapted for the particular ear phones used with the appliance, and test interface routines which support the communication between the appliance and the computer or other test processor on which a user interface is provided supporting the test. Also, the nonvolatile memory 1129 includes decoding resources
10 that support the playback of the customized audio data product read from the solid state memory card 1130. The decoding resources may include logic that utilizes parameters associated with the customized audio data product for a decoding data so that only an appliance or user having these particular parameters can playback the product. In alternative embodiments, the decoding resources are adapted for industry standard audio data encoding techniques.

15 In alternative embodiments, the appliance 1104 includes user input devices, such as buttons or a touch screen supporting a graphical user interface in the style of a personal digital assistant (PDA), for the test process, and the communication media connects to the Internet or other networks for access to remote test processors used to generate the hearing profile.

In summary, the present invention provides a system and method for producing hearing
20 profiles for customers to be used in the production of customized audio data products. The hearing profiles allow for the customized and optimized sound processing for each customer. The process can be optimized over time and over situations and for each modality for the delivery of the sound product. The customized audio data products are delivered via a variety of communication channels, to specific playback devices or to generic playback devices as suits a
25 particular customer.

The system and method of the present invention provide for delivery of optimized audio products to persons that do not use hearing aids or other assistive hearing devices. Audio products from a variety of sound data sources can be customized using hearing profiles, and delivered to a customer on demand.

30 While the present invention is disclosed by reference to the preferred embodiments and examples detailed above, it is to be understood that these examples are intended in an illustrative

rather than in a limiting sense. It is contemplated that modifications and combinations will readily occur to those skilled in the art, which modifications and combinations will be within the spirit of the invention and the scope of the appended claims.



CLAIMS

What is claimed is:

- 1 1. A system for producing customized audio data, comprising:
2 a source of an audio data product;
3 processing resources, coupled to the source of an audio data product, configured to
4 associate the audio data product with a customer hearing profile for use in production of a
5 customized audio data product.
- 1 2. The system of claim 1, wherein the customer hearing profile comprises
2 coefficients of a transfer function to transform the audio data product according a hearing
3 characteristic of a customer.
- 1 3. The system of claim 1, wherein the customer hearing profile comprises an
2 identifier of transfer function to transform the audio data product according a hearing
3 characteristic of a customer.
- 1 4. The system of claim 1, wherein the customer hearing profile comprises an
2 identifier of a transfer function and coefficients of the identified transfer function to transform
3 the audio data product according a hearing characteristic of a customer.
- 1 5. The system of claim 1, including a machine readable registry of customer hearing
2 profiles corresponding to registered customers of the audio data product in communication with
3 data processing resources, and further including resources for reading, modifying and writing
4 particular customer hearing profiles in the plurality.
- 1 6. The system of claim 1, wherein the customer hearing profile includes a value
2 indicating listening conditions in which the customized audio data product is to be played.



1 7. The system of claim 1, wherein the customer hearing profile includes a value
2 indicating a hearing characteristic of a customer for whom the customized audio data product is
3 to be played.

1 8. The system of claim 1, wherein the customer hearing profile includes a
2 specification of psycho-acoustic characteristics of a customer for whom the customized audio
3 data product is to be played.

1 9. The system of claim 1, wherein the customer hearing profile includes an
2 audiogram characterizing a customer for whom the customized audio data product is to be
3 played.

1 10. The system of claim 1, wherein the customer hearing profile includes software
2 defining a transfer function for producing the customized audio data product.

1 11. The system of claim 1, including a source of a plurality of customer hearing
2 profiles, and wherein the data processing resources include logic to accept data concerning a
3 customer for whom the customized audio data product is to be played, and to produce a customer
4 hearing profile for the plurality of customer hearing profiles in response to the accepted data.

1 12. The system of claim 1, including a source of a plurality of customer hearing
2 profiles, and wherein the data processing resources include a network interface, and logic to
3 accept, via the network interface, data concerning a customer for whom the customized audio
4 data product is to be played, and to produce a customer hearing profile for the plurality of
5 customer hearing profiles in response to the accepted data.

1 13. The system of claim 1, including a source of a plurality of customer hearing
2 profiles, and wherein the data processing resources include a network interface, and logic to
3 accept, via the network interface, data concerning a customer for whom the customized audio
4 data product is to be played, and to modify a customer hearing profile in the plurality of
5 customer hearing profiles in response to the accepted data.

1 14. The system of claim 1, including a source of a plurality of customer hearing
2 profiles, and wherein the data processing resources include a network interface, and an interface
3 accessible to a user via the network interface to accept data concerning a customer for whom the
4 customized audio data product is to be played, and to produce a customer hearing profile for the
5 plurality of customer hearing profiles in response to the accepted data.

1 15. The system of claim 1, including a source of a plurality of customer hearing
2 profiles, and wherein the data processing resources include a network interface, and an interface
3 accessible to a user via the network interface to accept data concerning a customer for whom the
4 customized audio data product is to be played, and to modify a customer hearing profile in the
5 plurality of customer hearing profiles in response to the accepted data.

1 16. The system of claim 1, wherein the processing resources include a network
2 interface for connection to a data network, and the source of the audio data product comprises
3 the network interface.

1 17. The system of claim 1, wherein the processing resources include a network
2 interface for connection to a data network, and resources to receive the customer hearing profile
3 via the network interface.

1 18. The system of claim 1, wherein the audio data product comprises pre-recorded
2 audio tracks.

1 19. The system of claim 1, wherein the audio data product comprises pre-recorded
2 audio music tracks.

1 20. The system of claim 1, wherein the audio data product comprises live audio
2 music streams.



1 21. The system of claim 1, wherein the audio data product comprises pre-recorded
2 audio voice tracks.

1 22. The system of claim 1, wherein the audio data product comprises live audio voice
2 streams.

1 23. The system of claim 1, wherein the audio data product comprises live audio
2 telephone data.

1 24. The system of claim 1, wherein the processing resources include a network
2 interface for connection to a data network, and user input comprises an interface accessible via
3 the network interface.

1 25. The system of claim 1, wherein the user input comprises tools by which a user
2 selects an instance of the encoded audio data product, and issues a request for the selected
3 instance.

1 26. The system of claim 1, including a source of a plurality of customer hearing
2 profiles, and wherein the user input comprises tools by which a user adds a customer hearing
3 profile to the plurality of customer hearing profiles.

1 27. The system of claim 1, including a source of a plurality of customer hearing
2 profiles, and wherein the user input comprises tools by which a user modifies a particular
3 customer hearing profile in the plurality of customer hearing profiles.

1 28. The system of claim 1, wherein the processing resources include logic to produce
2 information about billing for requested audio data products for customers.

1 29. The system of claim 1, wherein the audio data product comprises a digitally
2 encoded product.



1 30. The system of claim 1, wherein the audio data product comprises an analog
2 encoded product.

1 31. The system of claim 1, wherein the audio data product comprises data encoded
2 according to a particular format suitable for playback by audio systems adapted for the particular
3 format, and the customized audio data product comprises data encoded according to the
4 particular format.

1 32. The system of claim 1, wherein the data processing resources include a processor
2 which transforms the audio data product to the customized audio data product using the
3 customer hearing profile, a network interface, and logic for transmitting the customized audio
4 data product to a remote location via the network interface.

1 33. The system of claim 1, wherein the data processing resources include a network
2 interface, and logic for transmitting the audio data product and at least a portion of the customer
3 hearing profile to a remote location via the network interface.

1 34. The system of claim 1, wherein the data processing resources include a network
2 interface, and logic for transmitting at least a portion of the customer hearing profile to a remote
3 location via the network interface for use in transforming the audio data product.

1 35. The system of claim 1, wherein the data processing resources include a processor
2 which transforms the audio data product to the customized audio data product using the
3 customer hearing profile, a memory device to store data on a machine readable medium, and
4 logic for storing the customized audio data product on the machine readable medium.

1 36. The system of claim 1, wherein the processing resources comprise a processor
2 coupled to a device for playing the customized audio data product.

1 37. The system of claim 1, wherein the processing resources comprise a processor
2 coupled to a network, and resources for transmitting the customized audio data product to the
3 customer via the network.

1 38. The system of claim 1, wherein the data processing resources include an interface
2 for reading a hearing profile from a portable data storage device.

1 39. A method for producing customized audio data, comprising:
2 providing an interface for access to an audio data product;
3 receiving a request for the audio data product from a customer;
4 receiving a customer hearing profile associated with the customer; and
5 associating the audio data product with the customer hearing profile for use in production
6 of a customized audio data product.

1 40. The method of claim 39, including:
2 producing the customized audio data product in response to the audio data product and
3 the customer hearing profile, and transmitting the customized audio data product to a remote
4 site.

1 41. The method of claim 39, including:
2 producing the customized audio data product in response to the audio data product and
3 the customer hearing profile, and storing the customized audio data product on a machine
4 readable medium.

1 42. The method of claim 39, including:
2 producing the customized audio data product in response to the audio data product and
3 the customer hearing profile, and transducing the customized audio data product to sound.

1 43. The method of claim 39, including transmitting the audio data product and the
2 customer hearing profile to a remote site.

1 44. The method of claim 39, wherein the customer hearing profile comprises
2 coefficients of a transfer function to transform the audio data product according a psycho-
3 acoustic characteristic of a customer.

1 45. The method of claim 39, wherein the customer hearing profile comprises an
2 identifier of transfer function to transform the audio data product according a hearing
3 characteristic of a customer.

1 46. The method of claim 39, wherein the customer hearing profile comprises an
2 identifier of a transfer function and coefficients of the identified transfer function to transform
3 the audio data product according a hearing characteristic of a customer.

1 47. The method of claim 39, including providing a machine readable registry of
2 customer hearing profiles corresponding to registered customers of the audio data product, and
3 further including reading, modifying and writing particular customer hearing profiles in the
4 plurality to maintain the registry.

1 48. The method of claim 39, wherein the interface for access to the audio data
2 product comprises a network interface.

1 49. The method of claim 39, including providing a source of a plurality of customer
2 hearing profiles comprising a network interface.

1 50. The method of claim 39, wherein the audio data product comprises pre-recorded
2 audio tracks.

1 51. The method of claim 39, wherein the audio data product comprises pre-recorded
2 audio music tracks.

1 52. The method of claim 39, wherein the audio data product comprises live audio
2 music streams.



1 53. The method of claim 39, wherein the audio data product comprises pre-recorded
2 audio voice tracks.

1 54. The method of claim 39, wherein the audio data product comprises live audio
2 voice streams.

1 55. The method of claim 39, wherein the audio data product comprises live audio
2 telephone data.

1 56. The method of claim 39, including providing an interface accessible via a
2 network interface adapted to receive user input, including the request for the audio data product
3 and an identifier of the customer hearing profile.

1 57. The method of claim 39, including providing tools by which a user selects an
2 instance of the audio data product, and issues a request for the selected instance.

1 58. The method of claim 39, including providing a source of a plurality of customer
2 hearing profiles, and tools by which a user adds a customer hearing profile to the plurality of
3 customer hearing profiles.

1 59. The method of claim 39, including providing a source of a plurality of customer
2 hearing profiles, and tools by which a user modifies a particular customer hearing profile in the
3 plurality of customer hearing profiles.

1 60. The method of claim 39, including providing logic to produce information about
2 billing for requested audio data products for customers.

1 61. The method of claim 39, wherein the audio data product comprises a digitally
2 encoded product.

1 62. The method of claim 39, wherein the audio data product comprises an analog
2 encoded product.

1 63. The method of claim 39, wherein the audio data product comprises data encoded
2 according to a particular format suitable for playback by audio devices adapted for the particular
3 format, and the customized audio data product comprises data encoded according to the
4 particular format.

1 64. The method of claim 39, including providing a source of a plurality of customer
2 hearing profiles, and wherein a customer hearing profile in the plurality of customer hearing
3 profiles includes a value indicating an audio device on which the customized audio data product
4 is to be played.

1 65. The method of claim 39, wherein the customer hearing profile includes a value
2 indicating a hearing characteristic type of a customer for whom the customized audio data
3 product is to be played.

1 66. The method of claim 39, wherein the customer hearing profile includes a
2 specification of psycho-acoustic characteristics of a customer for whom the customized audio
3 data product is to be played.

1 67. The method of claim 39, wherein the customer hearing profile includes an
2 audiogram of a customer for whom the customized audio data product is to be played.

1 68. The method of claim 39, wherein the customer hearing profile includes software
2 defining a transfer function for producing the customized audio data product.

1 69. The method of claim 39, including providing a source of a plurality of customer
2 hearing profiles, accepting data concerning a customer for whom the customized audio data
3 product is to be played, and producing a customer hearing profile for the plurality of customer
4 hearing profiles in response to the accepted data.

1 70. The method of claim 39, including providing a source of a plurality of customer
2 hearing profiles, accepting data via a network interface concerning a customer for whom the
3 customized audio data product is to be played, and producing a customer hearing profile for the
4 plurality of customer hearing profiles in response to the accepted data.

1 71. The method of claim 39, including providing a source of a plurality of customer
2 hearing profiles, accepting data via a network interface, concerning a customer for whom the
3 customized audio data product is to be played, and modifying a customer hearing profile in the
4 plurality of customer hearing profiles in response to the accepted data.

1 72. The method of claim 39, including providing a source of a plurality of customer
2 hearing profiles, providing an interface accessible to a user via a network interface to accept data
3 concerning a customer for whom the customized audio data product is to be played, and
4 producing a customer hearing profile for the plurality of customer hearing profiles in response to
5 the accepted data.

1 73. The method of claim 39, including providing a source of a plurality of customer
2 hearing profiles, providing an interface accessible to a user via a network interface to accept data
3 concerning a customer for whom the customized audio data product is to be played, and
4 modifying a customer hearing profile in the plurality of customer hearing profiles in response to
5 the accepted data.

1 74. A method for providing customized audio data products, comprising:
2 accepting via a data network, machine readable orders from a customer for a particular
3 audio data product;
4 associating a hearing profile for the customer with the particular audio data product;
5 modifying the particular audio data product according to the hearing profile to produce a
6 customized audio data product; and
7 transmitting via a data network, a customized audio data product to the customer.

1 75. The method of claim 74, wherein the customized audio data product comprises at
2 least a portion of the hearing profile, and the particular audio data product for transformation
3 according to the hearing profile at a remote site.

1 76. The method of claim 74, wherein the customized audio data product comprises a
2 transformation according to the hearing profile of the particular audio data product.

1 77. The method of claim 74, including maintaining a registry of hearing profiles, and
2 the step of associating a hearing profile for the customer with the particular audio data product
3 includes retrieving the hearing profile from the registry.

1 78. The method of claim 77, including providing tools accessible via a network for
2 gathering information about hearing characteristics of customers, and modifying hearing profiles
3 in the registry in response to the information.

1 79. The method of claim 77, including providing tools accessible via a network for
2 gathering information about hearing characteristics of customers, and modifying hearing profiles
3 in the registry in response to the information according to an optimization modeling process.

1 80. The method of claim 74, wherein the particular audio data product comprises pre-
2 recorded audio tracks.

1 81. The method of claim 74, wherein the particular audio data product comprises pre-
2 recorded audio music tracks.

1 82. The method of claim 74, wherein the particular audio data product comprises live
2 audio music streams.

1 83. The method of claim 74, wherein the particular audio data product comprises pre-
2 recorded audio voice tracks.

1 84. The method of claim 74, wherein the particular audio data product comprises live
2 audio voice streams.

1 85. The method of claim 74, wherein the particular audio data product comprises live
2 audio telephone data.

1 86. The method of claim 74, including providing an interface accessible via a
2 network interface adapted to receive user input, including the request for the particular audio
3 data product and an identifier of the customer hearing profile.

1 87. The method of claim 74, including providing tools by which a user selects an
2 instance of the particular audio data product, and issues a request for the selected instance.

1 88. The method of claim 74, including providing a source of a plurality of customer
2 hearing profiles, and tools by which a user adds a customer hearing profile to the plurality of
3 customer hearing profiles.

1 89. The method of claim 74, including providing a source of a plurality of customer
2 hearing profiles, and tools by which a user modifies a particular customer hearing profile in the
3 plurality of customer hearing profiles.

1 90. The method of claim 74, including providing logic to produce information about
2 billing for particular audio data products for customers.

1 91. The method of claim 74, wherein the particular audio data product comprises a
2 digitally encoded product.

1 92. The method of claim 74, wherein the particular audio data product comprises an
2 analog encoded product.

1 93. The method of claim 74, wherein the particular audio data product comprises data
2 encoded according to a particular format suitable for playback by audio devices adapted for the
3 particular format, and the customized audio data product comprises data encoded according to
4 the particular format.

1 94. The method of claim 74, wherein the hearing profile includes a value indicating
2 listening conditions in which the customized audio data product is to be played.

1 95. The method of claim 74, wherein the hearing profile includes a value indicating a
2 hearing characteristic type of a customer for whom the customized audio data product is to be
3 played.

1 96. The method of claim 74, wherein the hearing profile includes a specification of
2 psycho-acoustic characteristics of a customer for whom the customized audio data product is to
3 be played.

1 97. The method of claim 74, wherein the hearing profile includes an audiogram of a
2 customer for whom the customized audio data product is to be played.

1 98. The method of claim 74, wherein the hearing profile includes software defining a
2 transfer function for producing the customized audio data product.

1 99. A method for providing customized audio data products, comprising:
2 storing a machine readable hearing profile for a customer;
3 accepting via a data network, machine readable orders from the customer for a particular
4 audio data product;
5 associating the hearing profile for the customer with the particular audio data product;
6 modifying the particular audio data product according to the hearing profile to produce a
7 customized audio data product;
8 delivering the customized audio data product to the customer;
9 accepting feedback from the customer concerning the customized audio data product; and

10 modifying the hearing profile in response to the feedback.

1 100. The method of claim 99, including:

2 providing input tools for accepting input data concerning a hearing profile for the
3 customer, and producing the machine readable hearing profile in response to the input data.

1 101. The method of claim 99, including:

2 providing a graphical user interface, accessible by the customer, for accepting input data
3 concerning a hearing profile for the customer, and producing the machine readable hearing
4 profile in response to the input data.

1 102. The method of claim 99, including:

2 providing a graphical user interface, accessible by the customer via a data network, for
3 accepting input data concerning a hearing profile for the customer, and producing the machine
4 readable hearing profile in response to the input data.

1 103. The method of claim 99, including:

2 providing input tools for accepting input data characterizing the feedback, and modifying
3 the machine readable hearing profile in response to the input data.

1 104. The method of claim 99, including:

2 providing a graphical user interface, accessible by the customer, for accepting input data
3 characterizing the feedback, and modifying the machine readable hearing profile in response to
4 the input data.

1 105. The method of claim 99, including:

2 providing a graphical user interface, accessible by the customer via a data network, for
3 accepting input data characterizing the feedback, and modifying the machine readable hearing
4 profile in response to the input data.

1 106. The method of claim 99, wherein the step of modifying comprises applying an
2 optimization modeling process to the hearing profile.

1 107. The method of claim 99, including maintaining a database including a plurality of
2 machine readable hearing profiles for a corresponding plurality of customers, and wherein the
3 step of modifying comprises applying an optimization modeling process to the hearing profile in
4 response to the feedback and to the database.

1 108. The method of claim 99, including determining listening conditions relevant to
2 playback of the customized audio data product, and wherein the step of modifying is responsive
3 to the determined listening conditions.

1 109. The method of claim 99, including determining a type of delivery for the
2 customized audio data product, and wherein the step of delivering is responsive to the
3 determined type of delivery.

1 110. The method of claim 99, including determining a type of delivery for the
2 customized audio data product, and wherein the step of modifying is responsive to the
3 determined type of delivery.

1 111. A method for providing customized audio data products, comprising:
2 reading a particular audio data product;
3 associating a hearing profile with the particular audio data product;
4 modifying the particular audio data product according to the hearing profile to produce a
5 customized audio data product.

1 112. The method of claim 111, wherein the step of associating a hearing profile with
2 the particular audio data product includes retrieving the hearing profile from a portable memory
3 device.

1 113. The method of claim 111 including maintaining a registry of hearing profiles, and
2 the step of associating a hearing profile for the customer with the particular audio data product
3 includes retrieving the hearing profile from the registry.

1 114. The method of claim 113, including providing tools accessible via a network for
2 gathering information about hearing characteristics of customers, and modifying hearing profiles
3 in the registry in response to the information.

1 115. The method of claim 113, including providing tools accessible via a network for
2 gathering information about hearing characteristics of customers, and modifying hearing profiles
3 in the registry in response to the information according to an optimization modeling process.

1 116. The method of claim 111, wherein the particular audio data product comprises
2 pre-recorded audio tracks.

1 117. The method of claim 111, wherein the particular audio data product comprises
2 pre-recorded audio music tracks.

1 118. The method of claim 111, wherein the particular audio data product comprises
2 live audio music streams.

1 119. The method of claim 111, wherein the particular audio data product comprises
2 pre-recorded audio voice tracks.

1 120. The method of claim 111, wherein the particular audio data product comprises
2 live audio voice streams.

1 121. The method of claim 111, wherein the particular audio data product comprises
2 live audio telephone data.

1 122. The method of claim 111, including providing tools by which a user selects an
2 instance of the particular audio data product, and issues a request for the selected instance.

1 123. The method of claim 111, including providing a source of a plurality of customer
2 hearing profiles, and tools by which a user adds a customer hearing profile to the plurality of
3 customer hearing profiles.

1 124. The method of claim 111, including providing a source of a plurality of customer
2 hearing profiles, and tools by which a user modifies a particular customer hearing profile in the
3 plurality of customer hearing profiles.

1 125. The method of claim 111, wherein the particular audio data product comprises a
2 digitally encoded product.

1 126. The method of claim 111, wherein the particular audio data product comprises an
2 analog encoded product.

1 127. The method of claim 111, wherein the particular audio data product comprises
2 data encoded according to a particular format suitable for playback by audio devices adapted for
3 the particular format, and the customized audio data product comprises data encoded according
4 to the particular format.

1 128. The method of claim 111, wherein the hearing profile includes a value indicating
2 listening conditions in which the customized audio data product is to be played.

1 129. The method of claim 111, wherein the hearing profile includes a value indicating
2 a hearing characteristic type of a customer for whom the customized audio data product is to be
3 played.

1 130. The method of claim 111, wherein the hearing profile includes a specification of
2 psycho-acoustic characteristics of a customer for whom the customized audio data product is to
3 be played.

1 131. The method of claim 111, wherein the hearing profile includes an audiogram of a
2 customer for whom the customized audio data product is to be played.

1 132. The method of claim 111, wherein the hearing profile includes software defining
2 a transfer function for producing the customized audio data product.

1 133. A device for producing customized audio data, comprising:
2 data storage storing an audio data product and
3 a hearing profile of a customer for the audio data product; and
4 logic to produce a customized audio data product in response to the hearing profile and
5 the audio data product.

1 134. The device of claim 133, including:
2 an interface by which the customized audio data product is received from a remote site.

1 135. The device of claim 133, including:
2 logic to store the customized audio data product on a machine readable medium.

1 136. The device of claim 133, wherein the customized audio data product comprises at
2 least a portion of the hearing profile, and the audio data product for transformation according to
3 the hearing profile at a remote site.

1 137. The device of claim 133, wherein the customized audio data product comprises a
2 transformation according to the hearing profile of the audio data product.

1 138. The device of claim 133, wherein the customized audio data product comprises a
2 transformation according to the hearing profile of the audio data product, and a parameter used
3 for decoding the transformation.

1 139. The device of claim 133, wherein the customized audio data product comprises a
2 transformation according to the hearing profile of the audio data product, and a parameter
3 associated with the customer used for decoding the transformation.

4 140. An article of manufacture comprising:
5 a data storage medium configured for connection to, and for disconnection from, an
6 audio playback device; and
7 a customized audio data product stored in the data storage medium, the customized audio
8 data product comprising an audio data product customized in response to a hearing profile of a
9 customer.

1 141. The article of claim 140, wherein the customized audio data product comprises a
2 transformation according to the hearing profile of the audio data product, and a parameter for
3 identification of the customer.

1 142. The article of claim 140, wherein the customized audio data product comprises at
2 least a portion of the hearing profile, and the audio data product for transformation according to
3 the hearing profile.

1 143. The article of claim 140, wherein the customized audio data product comprises a
2 transformation according to the hearing profile of the audio data product.

1 144. The article of claim 140, wherein the customized audio data product comprises a
2 transformation according to the hearing profile of the audio data product, and a parameter used
3 for decoding the transformation.

1 145. The article of claim 140, wherein the customized audio data product comprises a
2 transformation according to the hearing profile of the audio data product, and a parameter
3 associated with the customer used for decoding the transformation.

4 146. An audio data playback device comprising:
5 a data processor;
6 a data storage medium, coupled to the data processor;
7 an audio transducer, coupled to the data processor; and
8 a customized audio data product stored in the data storage medium, the customized audio
9 data product comprising an audio data product customized using a hearing profile of a customer.

1 147. The audio data playback device of claim 146, wherein the audio transducer
2 comprises a speaker mounted on a headset.

1 148. The audio data playback device of claim 146, wherein the audio transducer
2 comprises stereo speakers mounted on a headset.

1 149. The audio data playback device of claim 146, wherein the customized audio data
2 product comprises the audio data product transformed according to the hearing profile, and a
3 parameter for identification of the customer.

1 150. The audio data playback device of claim 146, wherein the customized audio data
2 product comprises a transformation according to the hearing profile of the audio data product,
3 and a parameter associating the customized audio data product with the customer, and the data
4 processor includes decoding logic responsive to the parameter for playing the customized audio
5 data product.

1 151. The audio data playback device of claim 146, wherein the customized audio data
2 product comprises at least a portion of the hearing profile, and the audio data product for
3 transformation according to the hearing profile, and the data processor includes decoding logic

4 responsive to said at least a portion of the hearing profile for playing the customized audio data
5 product.

1 152. An audio testing device comprising:
2 a data processor;
3 a data storage medium, coupled to the data processor;
4 a communication port, coupled to the data processor;
5 an audio transducer, coupled to the data processor; and
6 at least a portion of a hearing test program stored in the data storage medium, the hearing
7 test program comprising routines for execution of a hearing test using the communication port
8 and the hearing test program to produce hearing profile data of a customer.

1 153. The audio testing device of claim 152, wherein the communication port
2 comprises a port for connection to an external data processing device providing a user interface
3 for the hearing test program.

1 154. The audio testing device of claim 152, wherein the audio transducer comprises a
2 speaker mounted on a headset.

1 155. The audio testing device of claim 152, wherein the audio transducer comprises
2 stereo speakers mounted on a headset.

1 156. The audio testing device of claim 152, including a port adapted to couple a
2 removable data storage device to the data processor, and resources for playing an audio data
3 product stored in the removable data storage device.

1 157. The audio testing device of claim 152, including a battery, and wherein the data
2 processor and audio transducer are coupled to the battery.

1 158. The audio testing device of claim 152, including a headset, and wherein the data
2 processor, data storage medium, communication port and audio transducer are mounted on the
3 headset.

1 159. The audio testing device of claim 152, wherein the customer hearing profile
2 comprises coefficients of a transfer function to transform an audio data product according a
3 hearing characteristic of a customer.

1 160. The audio testing device of claim 152, wherein the customer hearing profile
2 comprises an identifier of transfer function to transform an audio data product according a
3 hearing characteristic of a customer.

1 161. The audio testing device of claim 152, wherein the customer hearing profile
2 comprises an identifier of a transfer function and coefficients of the identified transfer function
3 to transform an audio data product according a hearing characteristic of a customer.

1 162. The audio testing device of claim 152, wherein the customer hearing profile
2 includes a value indicating listening conditions in which a customized audio data product is to be
3 played.

1 163. The audio testing device of claim 152, wherein the customer hearing profile
2 includes a value indicating a hearing characteristic of a customer for whom a customized audio
3 data product is to be played.

1 164. The audio testing device of claim 152, wherein the customer hearing profile
2 includes a specification of psycho-acoustic characteristics of a customer for whom a customized
3 audio data product is to be played.

1 165. The audio testing device of claim 152, wherein the customer hearing profile
2 includes an audiogram characterizing a customer for whom a customized audio data product is to
3 be played.

1 166. The audio testing device of claim 152, wherein the customer hearing profile
2 includes software defining a transfer function for producing a customized audio data product.

1 167. An audio testing and playback device comprising:
2 a data processor;
3 data memory coupled to the data processor;
4 a communication port, coupled to the data processor;
5 an audio transducer, coupled to the data processor;
6 a hearing test program stored in the data memory, the hearing test program comprising
7 logic used for execution of a hearing test using the communication port to produce hearing
8 profile data for use in production of a hearing profile of a customer; and
9 a customized audio data product stored in the data memory, the customized audio data
10 product comprising an audio data product customized using the hearing profile.

1 168. The audio testing and playback device of claim 167, wherein the communication
2 port comprises a port for connection to an external data processing device providing a user
3 interface for the hearing test program.

1 169. The audio testing and playback device of claim 167, wherein the audio transducer
2 comprises a speaker mounted on a headset.

1 170. The audio testing and playback device of claim 167, wherein the audio transducer
2 comprises stereo speakers mounted on a headset.

1 171. The audio testing and playback device of claim 167, including a port adapted to
2 couple a removable data storage device to the data processor, and resources for playing an audio
3 data product stored in the removable data storage device.

1 172. The audio testing and playback device of claim 167, including a battery, and
2 wherein the data processor and audio transducer are coupled to the battery.

1 173. The audio testing and playback device of claim 167, including a headset, and
2 wherein the data processor, data memory, communication port and audio transducer are mounted
3 on the headset.

1 174. A method for conducting a hearing test, comprising:
2 providing a headset having stored therein audio test software;
3 coupling the headset to a data processor having a user interface;
4 executing a test using the audio test software and the user interface to develop a hearing
5 profile;
6 producing a customized audio data product using the hearing profile; and
7 playing the customized audio data product on the headset.

1 175. The method of claim 174, including storing the hearing profile on the headset,
2 and wherein the step of producing a customized audio data product comprises processing an
3 audio data product using the hearing profile stored in the headset.

1 176. The method of claim 174, including storing the hearing profile in a remote site.

1 177. The method of claim 174, including producing the customized audio data product
2 in a remote site.

1 178. The method of claim 174, including storing the customized audio data product on
2 a machine readable medium, and coupling the machine readable medium to the headset.

1 179. The method of claim 174, including storing the customized audio data product on
2 a portable data storage device, and coupling the portable data storage device to the headset.

1 180. An article of manufacture comprising:
2 a data storage medium configured for connection to, and for disconnection from, an
3 audio playback device; and

4 a customer hearing profile stored in the data storage medium, the hearing profile
5 comprising data generated based on hearing characteristics of a particular customer.

1 181. The article of claim 180, wherein the customer hearing profile comprises
2 coefficients of a transfer function to transform an audio data product according a hearing
3 characteristic of a customer.

1 182. The article of claim 180, wherein the customer hearing profile comprises an
2 identifier of a transfer function to transform an audio data product according a hearing
3 characteristic of a customer.

1 183. The article of claim 180, wherein the customer hearing profile comprises an
2 identifier of a transfer function and coefficients of the identified transfer function to transform an
3 audio data product according a hearing characteristic of a customer.

1 184. The article of claim 180, wherein the customer hearing profile includes a value
2 indicating listening conditions in which a customized audio data product is to be played.

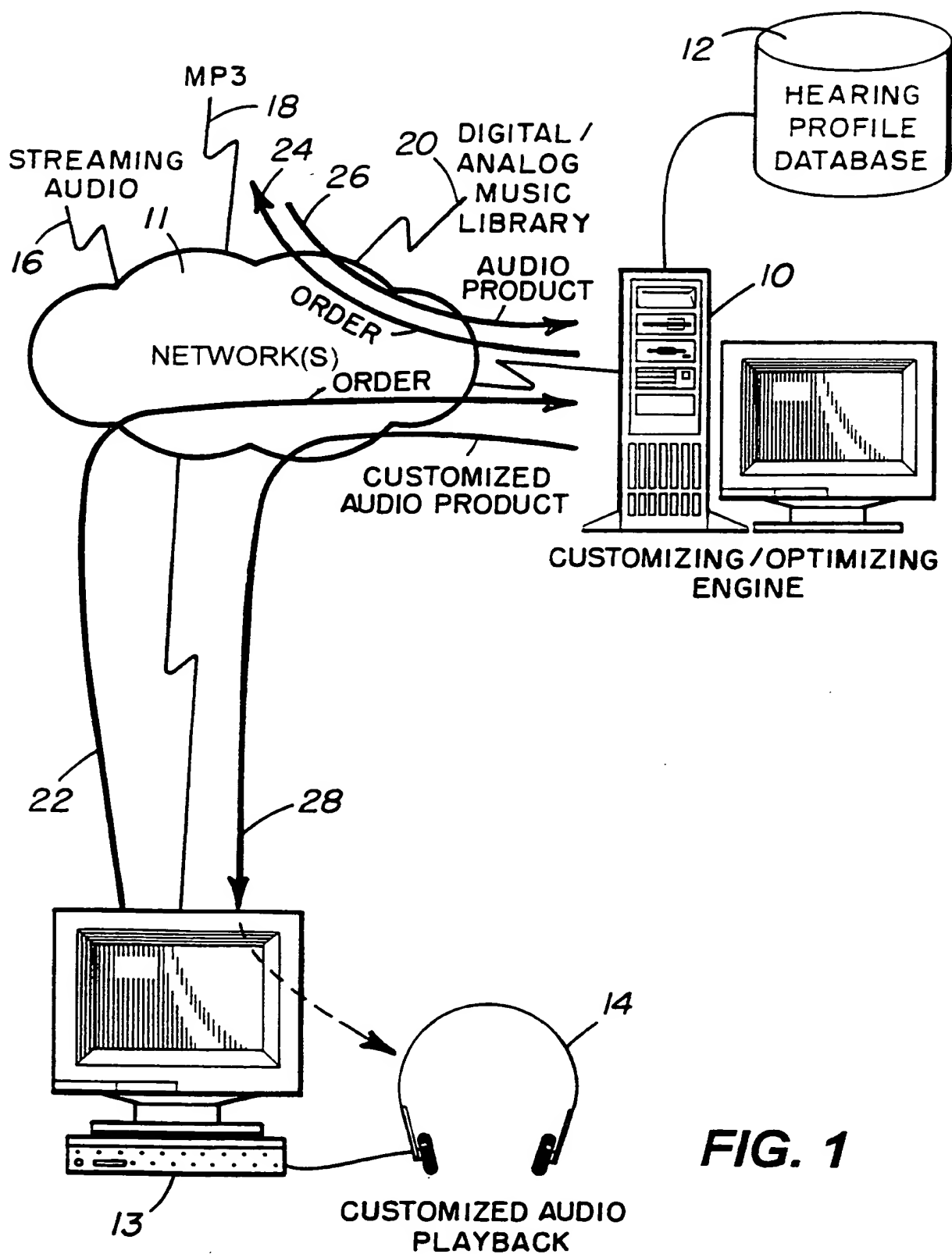
1 185. The article of claim 180, wherein the customer hearing profile includes a value
2 indicating a hearing characteristic of a customer for whom a customized audio data product is to
3 be played.

1 186. The article of claim 180, wherein the customer hearing profile includes a
2 specification of psycho-acoustic characteristics of a customer for whom a customized audio data
3 product is to be played.

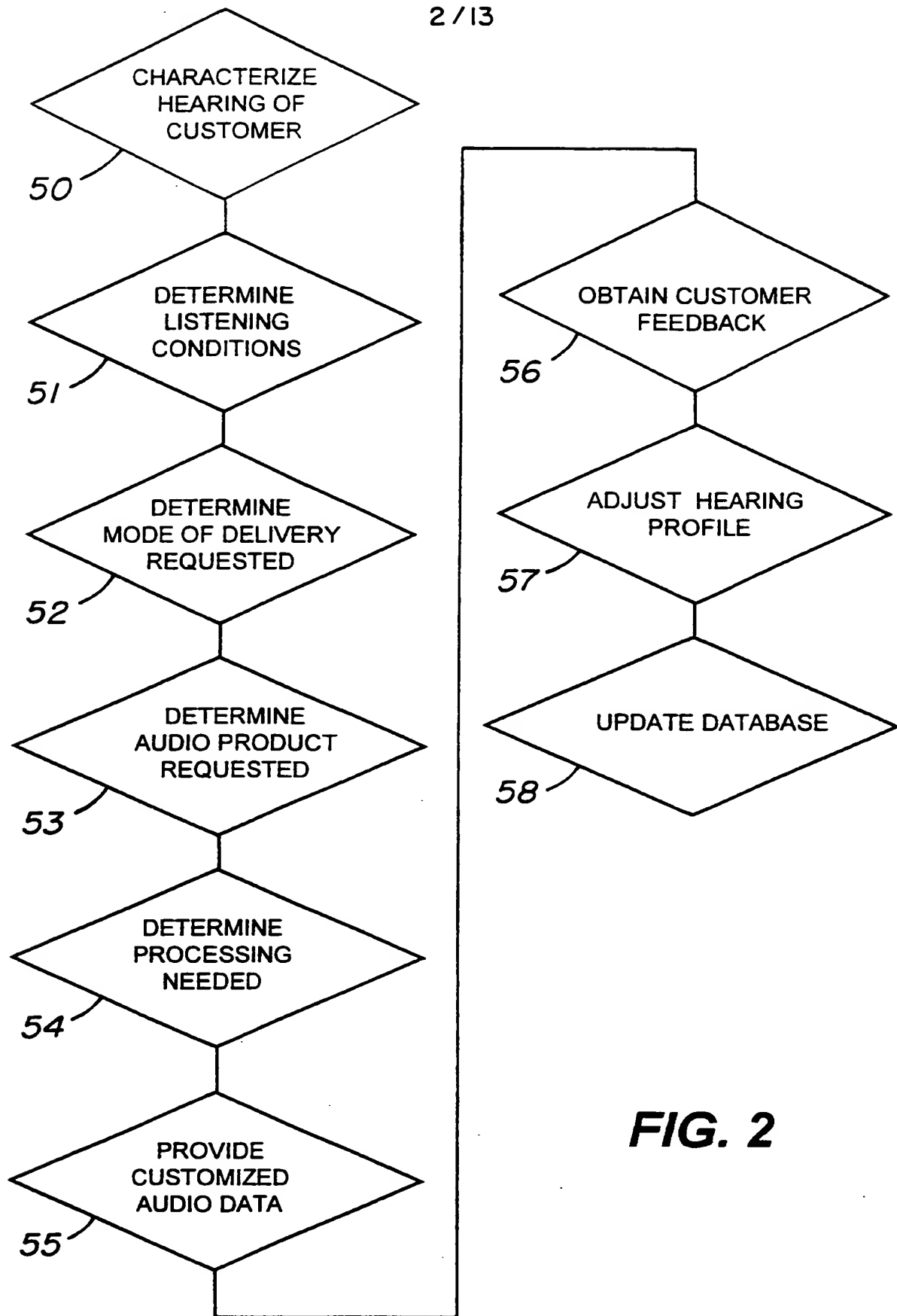
1 187. The article of claim 180, wherein the customer hearing profile includes an
2 audiogram characterizing a customer for whom a customized audio data product is to be played.

1 188. The article of claim 180, wherein the customer hearing profile includes software
2 defining a transfer function for producing a customized audio data product.

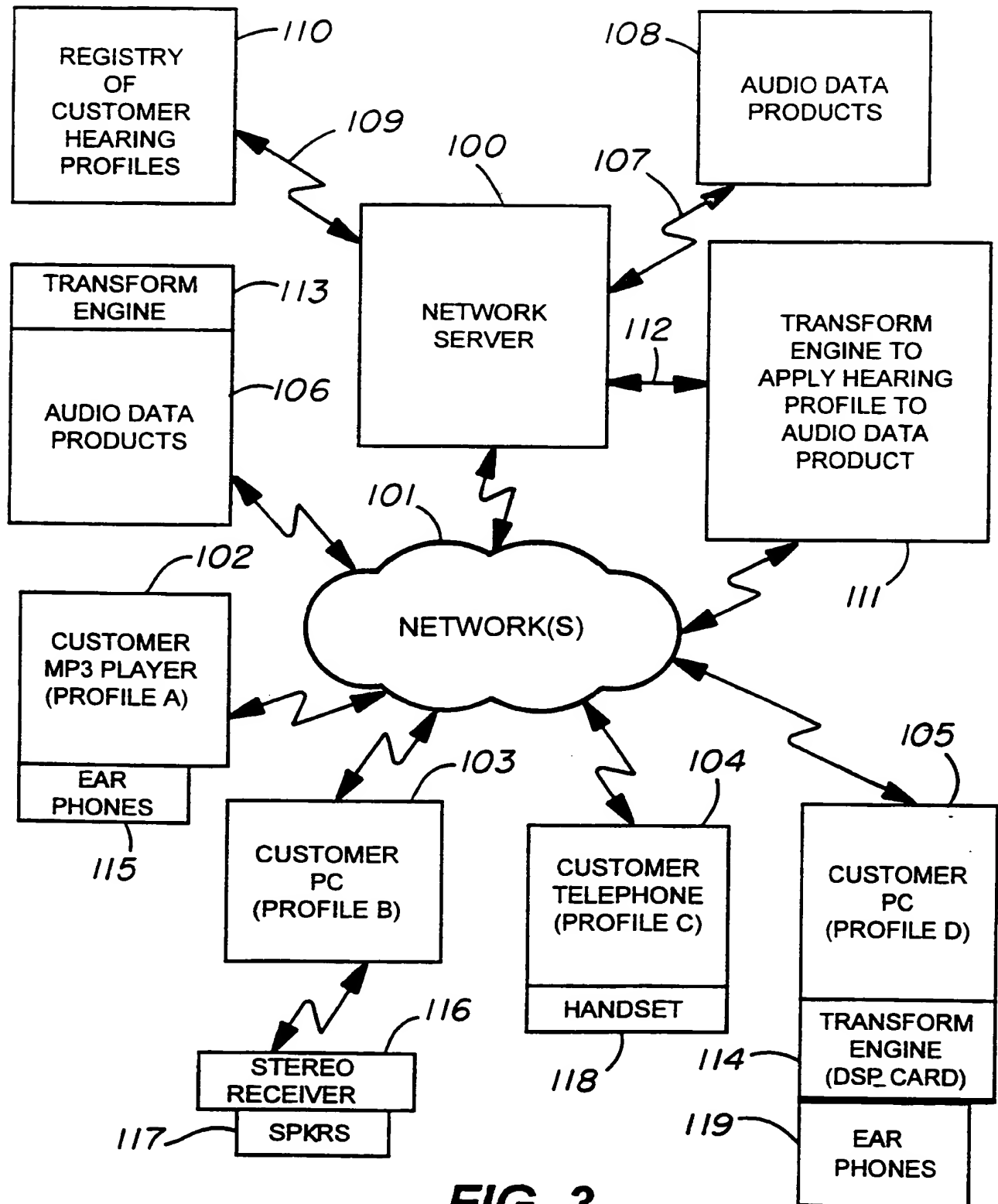
1/13

**FIG. 1**

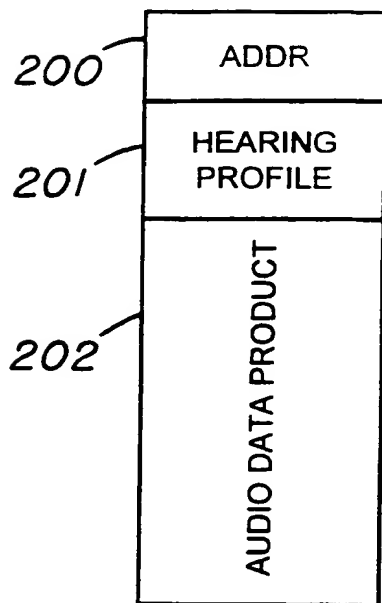
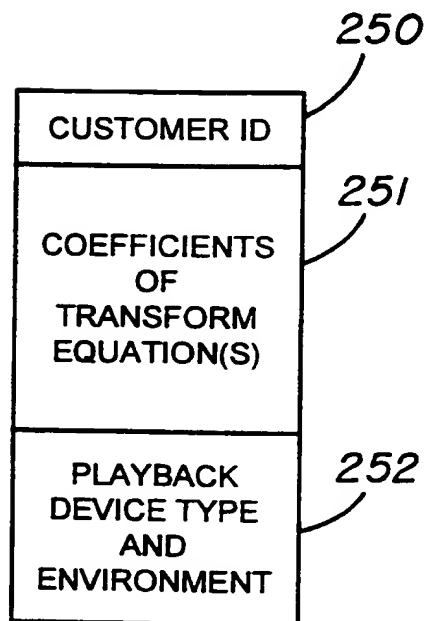
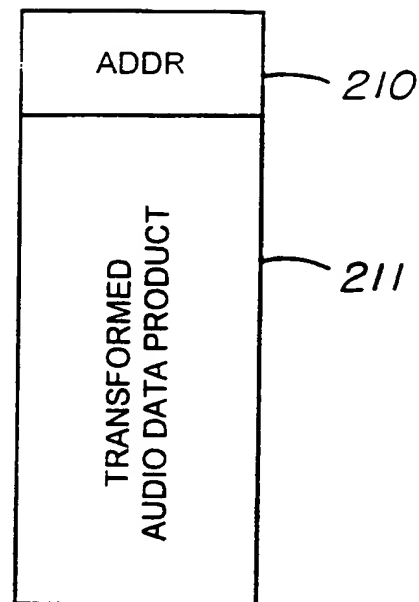
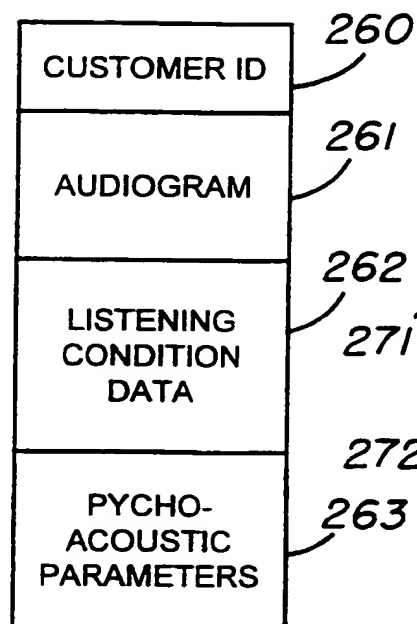
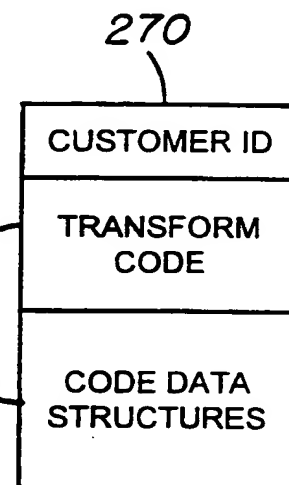
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**FIG. 2**

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**FIG. 3**

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FIG. 4**FIG. 5****FIG. 6****FIG. 7****FIG. 8**

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SELECT AUDIO PRODUCT PAGE 300

MP3 MUSIC FILE	<input type="checkbox"/> 301
STREAMING AUDIO (e.g. RADIO FORMAT)	<input type="checkbox"/> 302
LIVE AUDIO (e.g. WEB BROADCAST PERFORMANCE)	<input type="checkbox"/> 303

FIG. 9

PROFILE SET UP PAGE 310

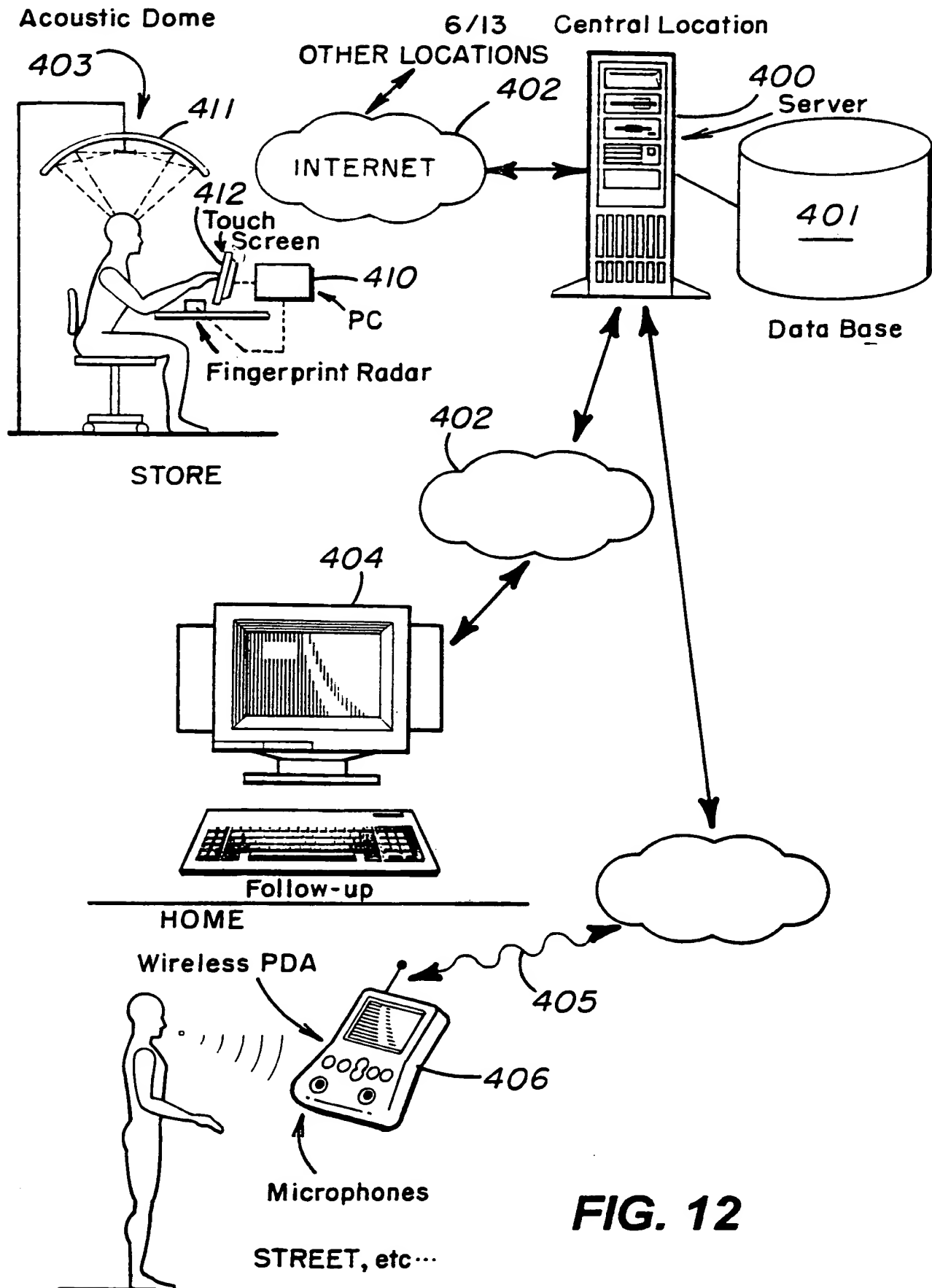
ENTER AUDIOLOGICAL DATA	<input type="checkbox"/> 311
ENTER PLAYBACK DEVICE TYPE(S)	<input type="checkbox"/> 312
ENTER ENVIRONMENTAL PARAMETERS	<input type="checkbox"/> 313

FIG. 10

PROFILE FEEDBACK PAGE 320

ENTER SUBJECTIVE PERFORMANCE DATA	<input type="checkbox"/> 321
ENTER PLAYBACK DEVICE TYPE(S)	<input type="checkbox"/> 322
ENTER ENVIRONMENTAL PARAMETERS	<input type="checkbox"/> 323

FIG. 11

**FIG. 12**

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EACH PATIENT

\bar{p} $\xrightarrow{i \leftarrow i+1}$

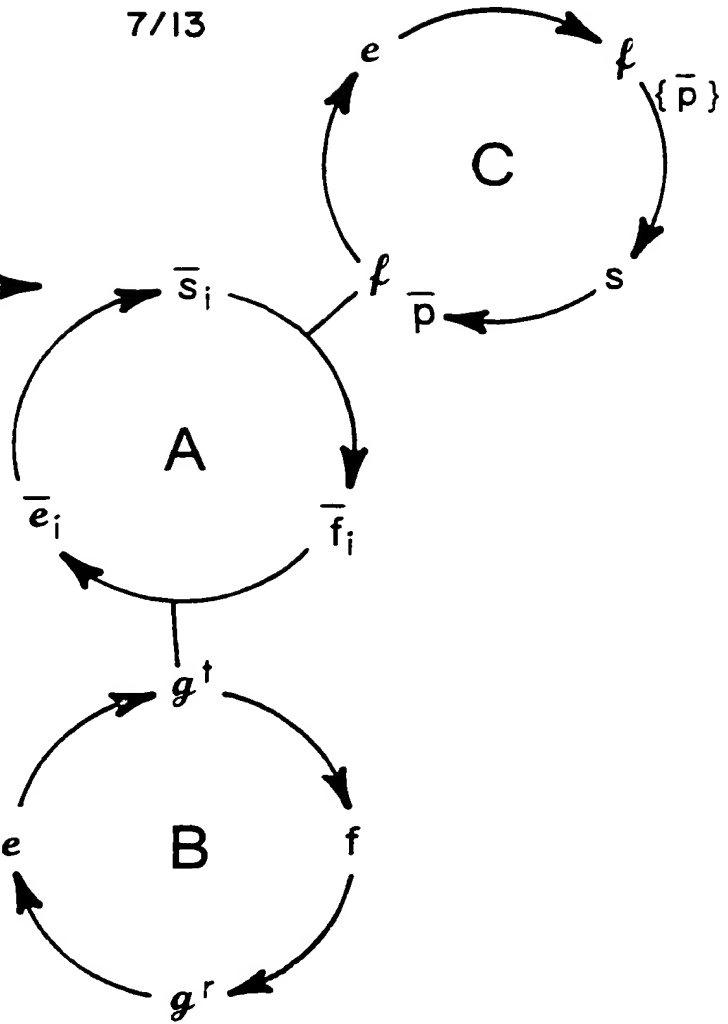
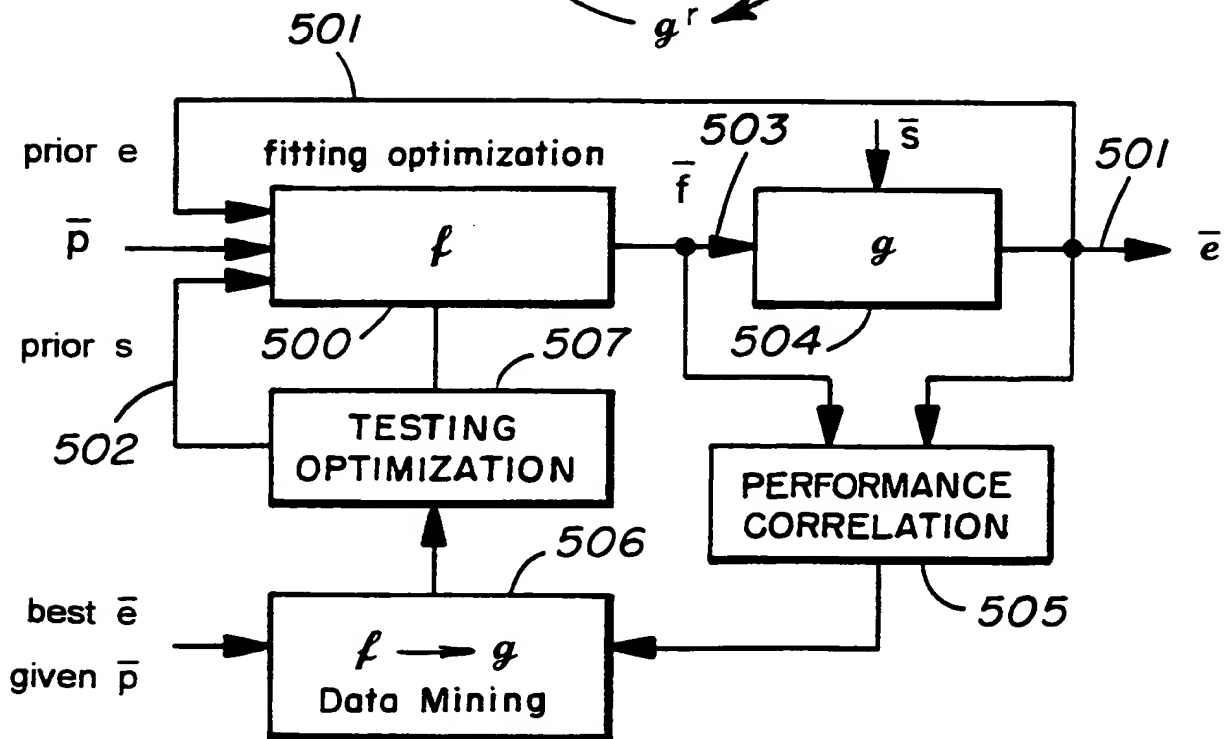


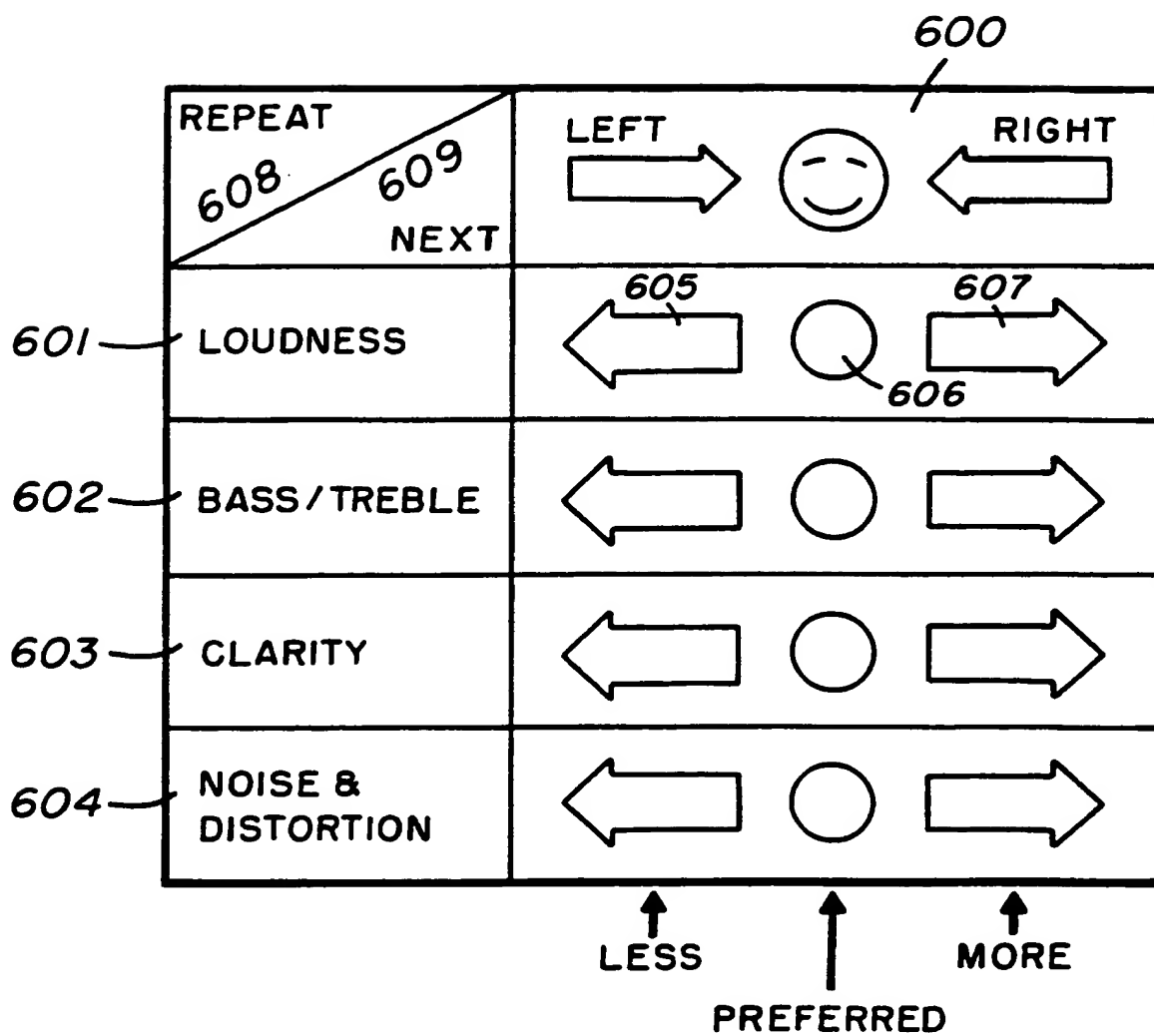
FIG. 13

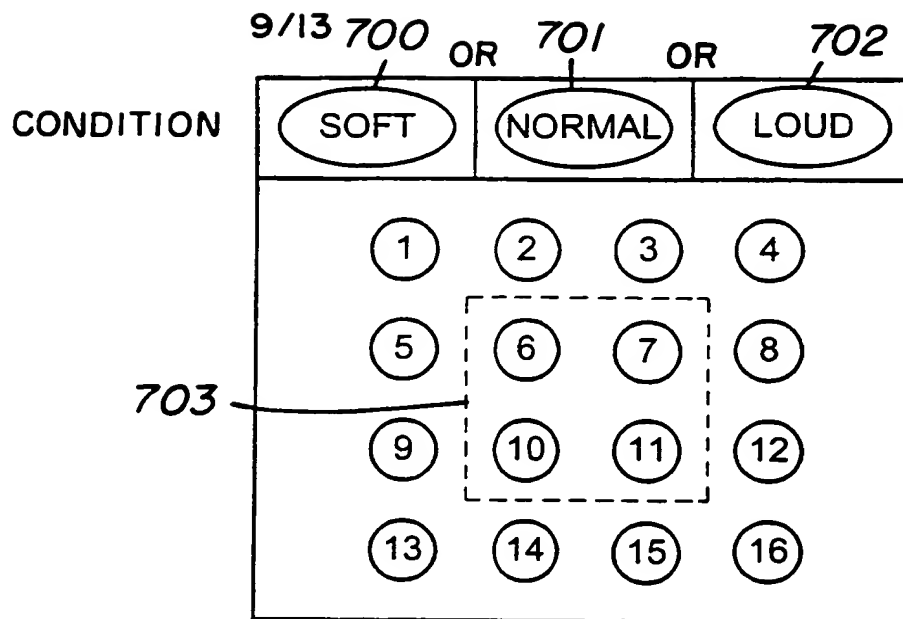


reference model

FIG. 14

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**FIG. 15**

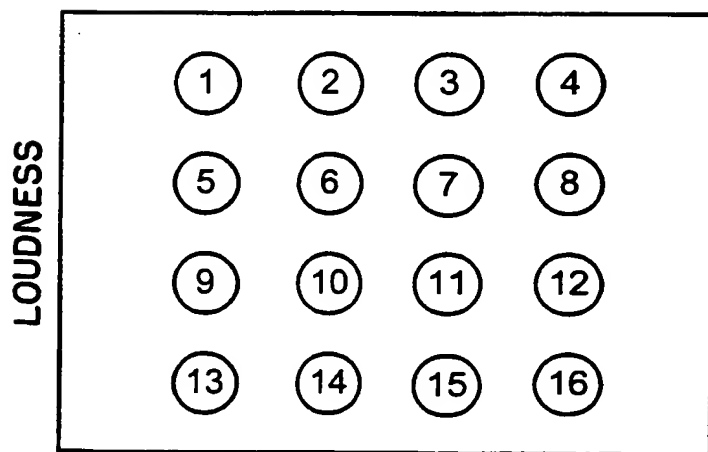


EVALUATING

PREFERRED

(A)

FIG. 16

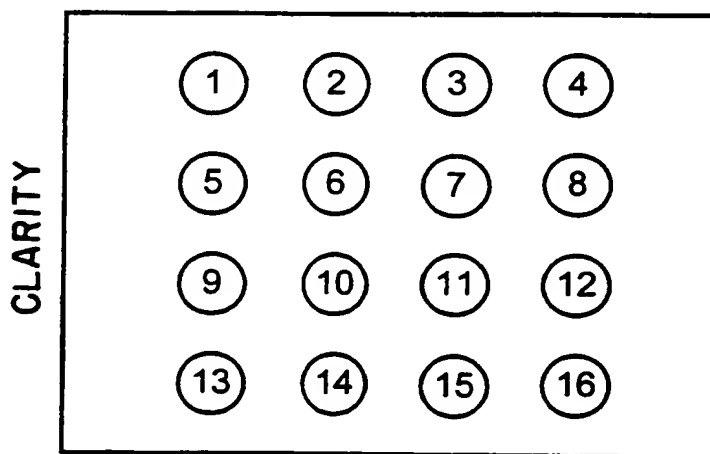


BALANCE

FIG. 17

PREFERRED

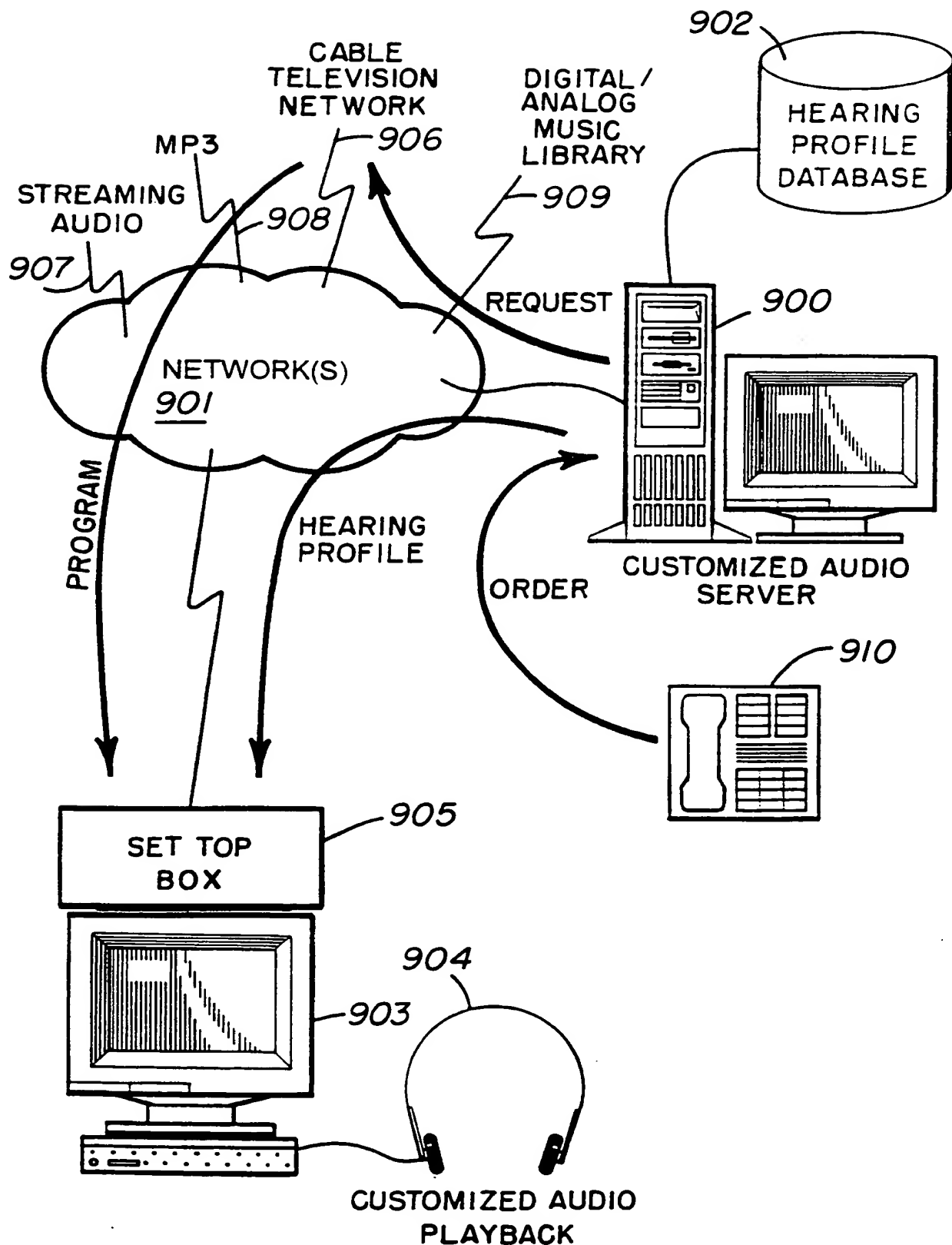
(B)



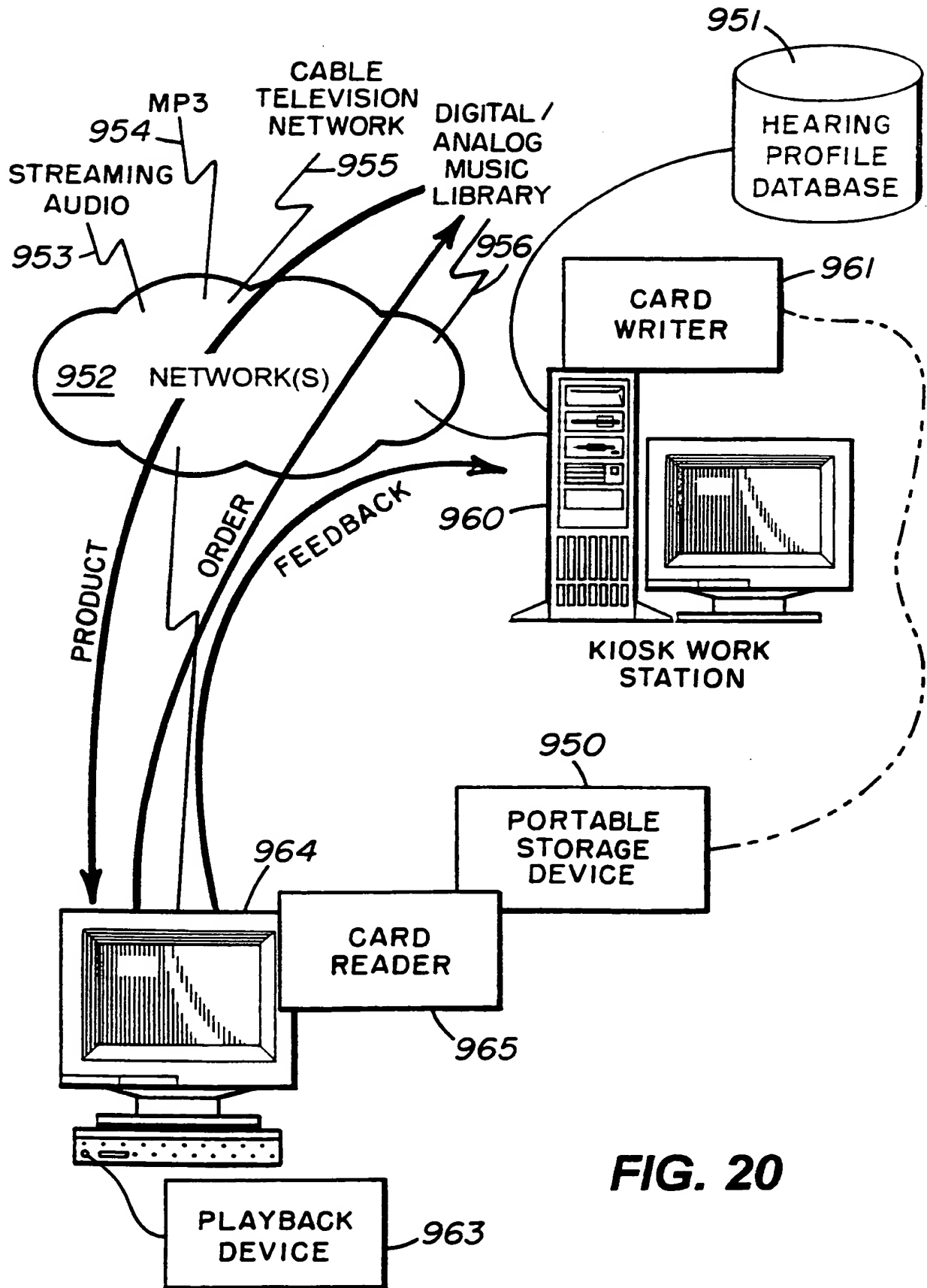
NOISE / DISTORTION

FIG. 18

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**FIG. 19**

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**FIG. 20**

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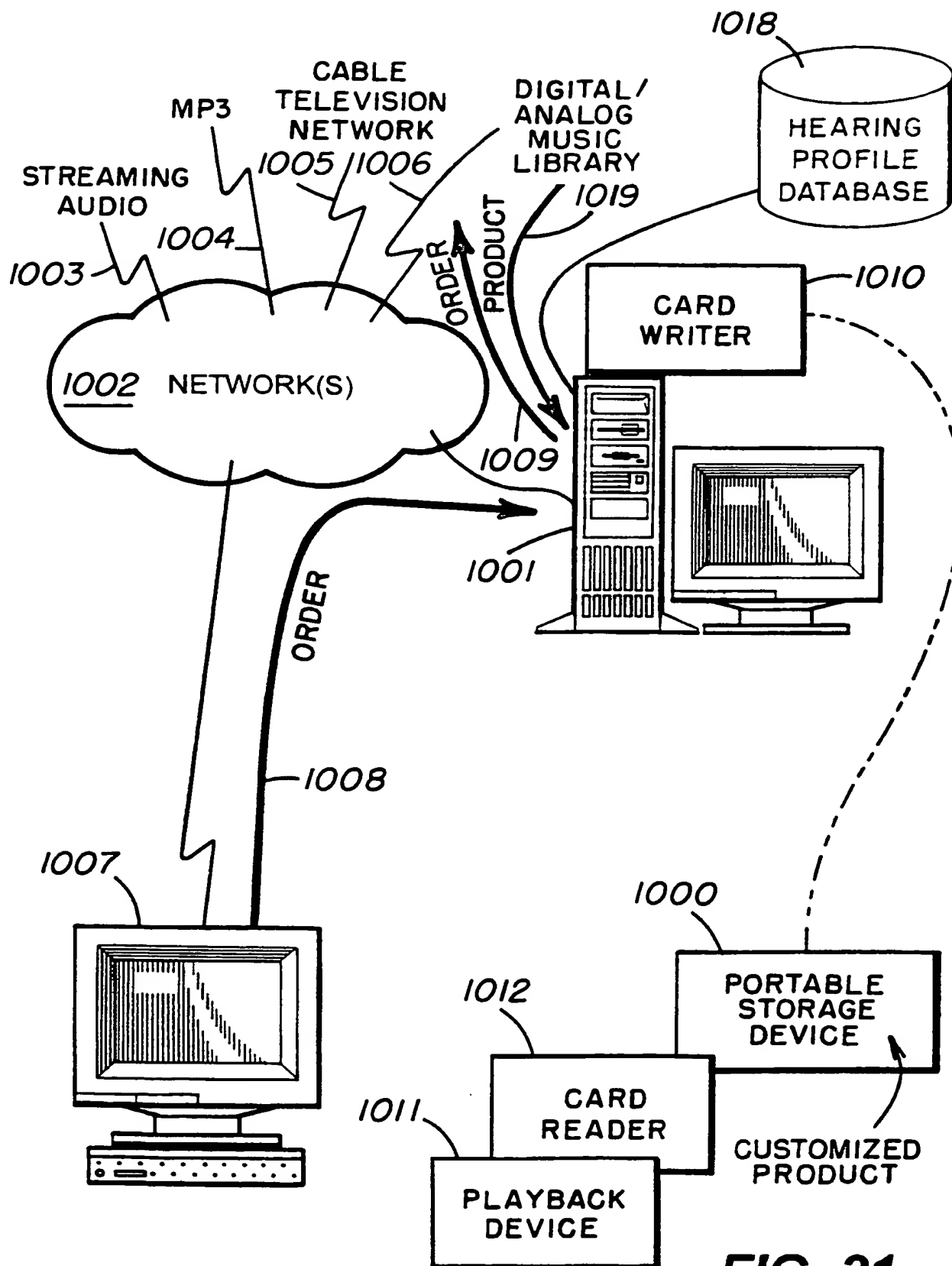
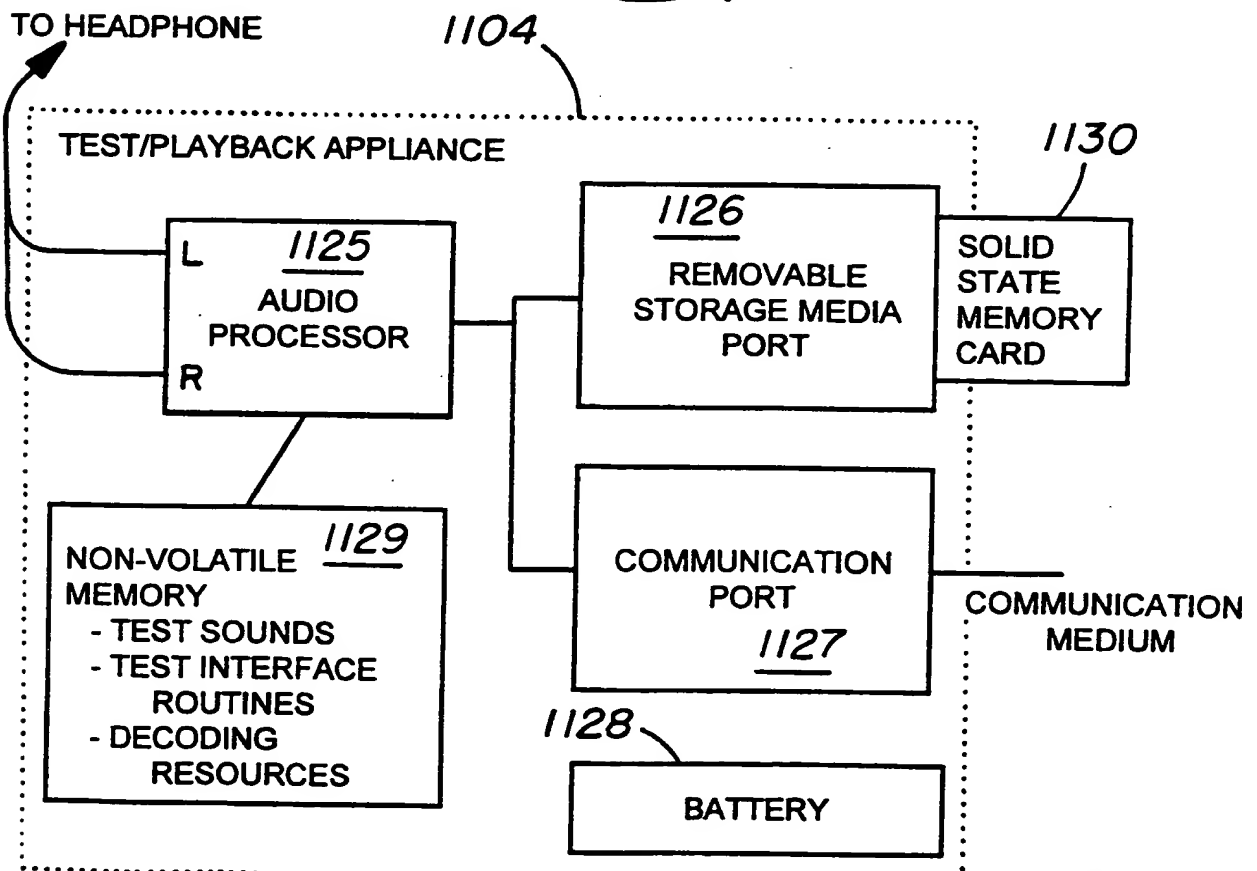
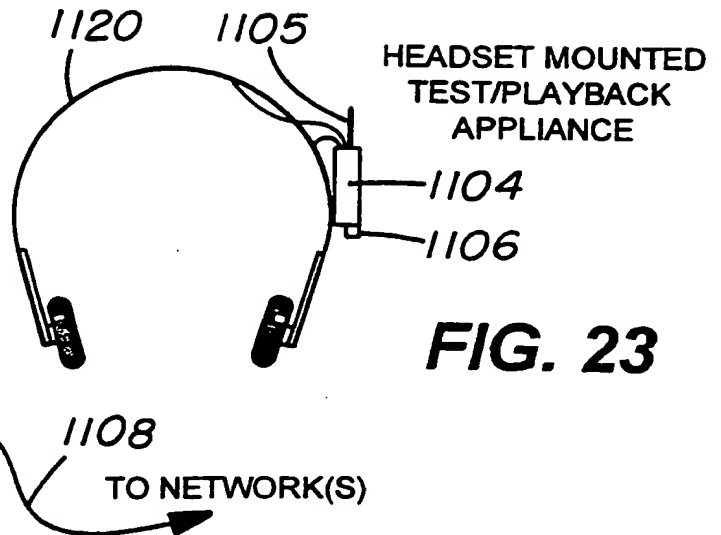
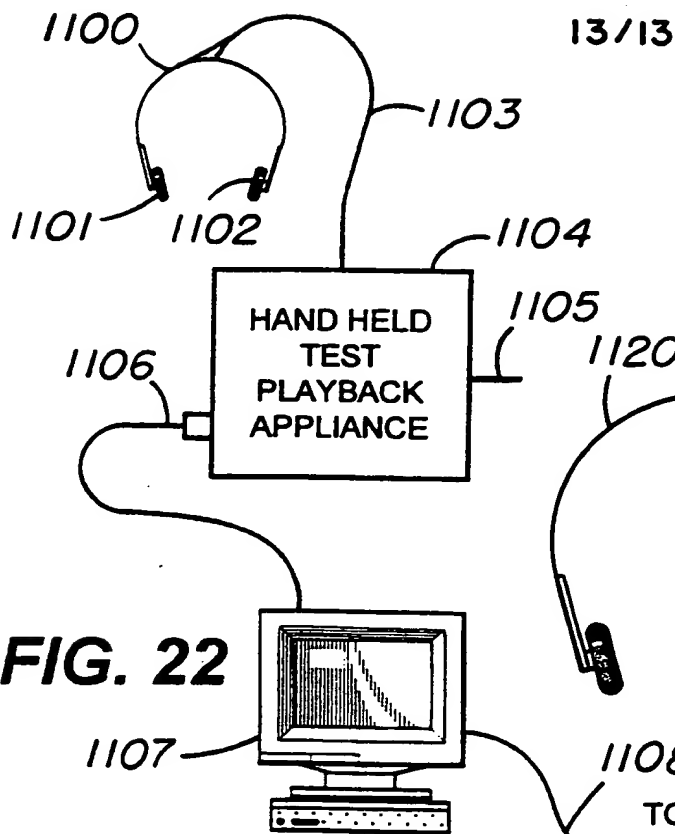


FIG. 21



INTERNATIONAL SEARCH REPORT

International application No.

PCT/US00/26231

A. CLASSIFICATION OF SUBJECT MATTER

IPC(7) :H04R 5/00, 1/10, 5/02

US CL :381/1, 310, 74, 303, 304, 305.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

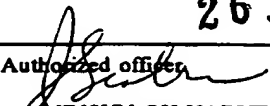
U.S. : 381/1, 310, 74, 303, 304, 305,

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
NONEElectronic data base consulted during the international search (name of data base and, where practicable, search terms used)
NONE**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 5,371,799 A (LOWE et al) 06 December 1994, figs. 3-11.	1-188
Y	US 5,854,843 A (JACKNIN et al) 29 December 1998, fig. 1.	1-188
Y	US 5,495,534 A (INANAGA et al) 27 February 1996, figs. 1-6.	1-188
Y	US 5,452,359 A (INANAGA et al) 19 September 1995, figs. 1-6.	1-188

☐ Further documents are listed in the continuation of Box C.
 ☐ See patent family annex.

* Special categories of cited documents:	*T* later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
A document defining the general state of the art which is not considered to be of particular relevance	*X* document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
B earlier document published on or after the international filing date	*Y* document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
L document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	*G* document member of the same patent family
O document referring to an oral disclosure, use, exhibition or other means	
P document published prior to the international filing date but later than the priority date claimed	

Date of the actual completion of the international search 15 NOVEMBER 2000	Date of mailing of the international search report 26 JAN 2001
Name and mailing address of the ISA/US Commissioner of Patents and Trademarks Box PCT Washington, D.C. 20231 Facsimile No. (703) 305-3230	Authorized officer  MINSUN OH HARVEY Telephone No. (703) 308-6741